VOLUME 62 • SEPTEMBER 1959 • NUMBER 3

# OPHTHALMOLOGY

**Urea as an Osmotic Ocular Hypotensive Agent in Glaucoma**
*Miles A. Galin, Futaba Aizawa, and John M. McLean*

**Parallel Retinal Folds**
*Thomas R. Hedges Jr. and Irving H. Leopold*

**Postmortem Chemistry of the Vitreous Body in Man**
*Hans N. Naumann*

**Ataxia-Telangiectasia**
*J. Lawton Smith and David G. Cogan*

**Hypophysectomy as a Therapeutical Method for Proliferative Diabetic Retinopathy**
*S. Vannas, C. A. Hernberg, and G. af Björkesten*

**The Treatment of Ophthalmic Herpes Zoster with Protamide**
*G. Scassellati Sforzolini*

**ERG of Congenital Totally Color-Weak Eye Accompanied by Lesion of Optic Nerve**
*Takashi A. Suzuki*

**Visual Acuity in Normal and Amblyopic Patients Under Reduced Illumination**
*Gunter K. von Noorden and Hermann M. Burian*

**The Treatment of Chronic Uveitis**
*Dan M. Gordon*

**Therapeutic Keratoplasty in Mooren's Ulcer**
*Philip C. Grana*

**Subdural Membrane with Arachnoiditis of the Optic Chiasm**
*Martin M. Mandel and Charles G. Steinmetz III*

**Experimental Ocular Infection with Nocardia Asteroides in the Normal Rabbit**
*James L. McCarthy, Roscoe J. Kennedy, and John B. Hazard*

**Effects of "Invisible" Lens Aberrations**
*Murray F. McCaslin*

**The Use of Dexamethasone in Ophthalmologic Steroid Therapy**
*Ray H. Nielsen*

**The Scleral Buckling Procedures**
*I. D. Okamura, C. L. Schepens, and R. J. Brockhurst*

**An Evaluation of Tonometric Techniques**
*K. Elizabeth Pierce Olmsted*

**Reading Aids for the Partially Blind**
*Louise L. Sloan and Maria D. Jablonski*

**Application of Television Ophthalmoscope to Some Problems of Clinical Ophthalmology**
*Albert M. Potts, Seymour S. West, and John R. Shearer*

**Translucent Behavior of Opaque Cornea**
*Arpad G. Gerard*

**Accessory Instrumentation for the Scleral Buckling Operation**
*R. David Sudarsky and Herbert M. Katzin*

**Hereditary Changes in Skin of the Eyelids**
*Jesse M. Levitt*

**The Orbit**
*Frank C. Winter*

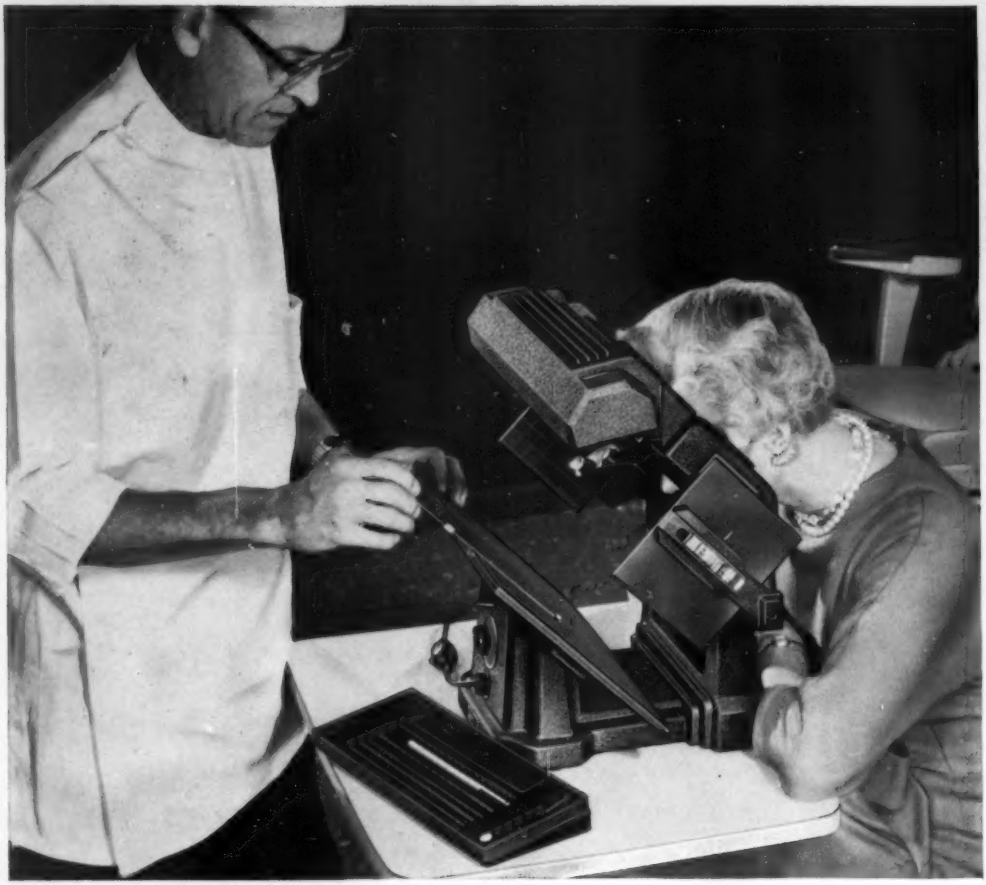
**Correspondence**

**Obituary: Watson Gailey, M.D.**

**News and Comment**

**Books**

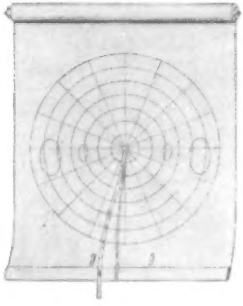
AMERICAN MEDICAL ASSOCIATION PUBLICATION



# *AO-LLOYD Stereo Campimeter*

**The only Campimeter which allows you to map full paracentral and central fields under stereoscopic fixation**

The measurable area extends 30° above and below the fixation point, 47° nasally and 35° temporally. Eye being examined maintains steady fixation by means of peripheral fusion even though a central scotoma exists. Exclusive "mirror septum" and side fixation targets are adjustable for pupillary distance and phorias. Variable daylight illumination of uniform intensity. Wide range of test targets with case, including a 1/4° white test object for detailed charting.



**Gruss Tangent Screen** (60" x 72") is used extensively in the charting of central and paracentral fields. Your choice of neutral gray or black mothproofed felt. The screen is charted with semi-visible, stitched concentric circles and 22.5° radial lines for use in measuring the mapped fields at either 1 or 2 meter test distances. Each screen equipped with ten targets in various sizes and colors. Standard equipment includes target wand, spring roller, mounting brackets, instructions, target set and 25 recording charts.

*See your AO Representative or Supplier, or write:*

American Optical COMPANY

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

Dept. U244

Please send me folder OE containing full information on AO Field Charting Instruments.

Name _____

Address _____

City _____ Zone ____ State _____

# TABLE OF CONTENTS

VOLUME 62 | SEPTEMBER 1959 | NUMBER 3

## ORIGINAL ARTICLES

PAGE

**Urea as an Osmotic Ocular Hypotensive Agent in Glaucoma**
*Miles A. Galin, M.D.; Futaba Aizawa, M.D., and John M. McLean, M.D., New York* ..... 347

**Parallel Retinal Folds**
*Thomas R. Hedges Jr., M.D., and Irving H. Leopold, M.D., Philadelphia* ..... 353

**Postmortem Chemistry of the Vitreous Body in Man**
*Hans N. Naumann, M.D., Memphis* ..... 356

**Ataxia-Telangiectasia**
*J. Lawton Smith, M.D., and David G. Cogan, M.D., Boston* ..... 364

**Hypophysectomy as a Therapeutical Method for Proliferative Diabetic Retinopathy**
*S. Vannas, M.D.; C. A. Hernberg, M.D., and G. af Björkesten, M.D., Helsinki, Finland* ..... 370

**The Treatment of Ophthalmic Herpes Zoster with Protamide**
*G. Scassellati Sforzolini, M.D., Bologna, Italy* ..... 381

**ERG of Congenital Totally Color-Weak Eye Accompanied by Lesion of Optic Nerve**
*Takashi A. Suzuki, M.D., Morioka, Japan* ..... 386

**Visual Acuity in Normal and Amblyopic Patients Under Reduced Illumination**
*Gunter K. von Noorden, M.D., and Hermann M. Burian, M.D., Iowa City* ..... 396

**The Treatment of Chronic Uveitis**
*Dan M. Gordon, M.D., New York* ..... 400

**Therapeutic Keratoplasty in Mooren's Ulcer**
*Philip C. Grana, M.D., Braddock, Pa.* ..... 414

**Subdural Membrane with Arachnoiditis of the Optic Chiasm**
*Martin M. Mandel, M.D., and Charles G. Steinmetz III, M.D., Philadelphia* ..... 419

**Experimental Ocular Infection with Nocardia Asteroides in the Normal Rabbit**
*James L. McCarthy, M.D.; Roscoe J. Kennedy, M.D., and John B. Hazard, M.D., Cleveland* ..... 425

**Effects of "Invisible" Lens Aberrations**
*Murray F. McCaslin, M.D., Pittsburgh* ..... 434

**The Use of Dexamethasone in Ophthalmologic Steroid Therapy**
*Ray H. Nielsen, M.D., North Hollywood, Calif.* ..... 438

**The Scleral Buckling Procedures**
*I. D. Okamura, M.D.; C. L. Schepens, M.D., and R. J. Brockhurst, M.D., Boston* ..... 445

**An Evaluation of Tonometric Techniques**
*K. Elizabeth Pierce Olmsted, M.D., Buffalo* ..... 459

**Reading Aids for the Partially Blind**
*Louise L. Sloan, Ph.D., and Maria D. Jablonski, F.B.O.A., Baltimore* ..... 465

**Application of Television Ophthalmoscope to Some Problems of Clinical Ophthalmology**
*Albert M. Potts, M.D.; Seymour S. West, B.E.E., and John R. Shearer, Cleveland* ..... 485

**Translucent Behavior of Opaque Cornea**
*Arpad G. Gerard, M.D., Woodbridge, N. J.* ..... 500

## CLINICAL NOTES, NEW INSTRUMENTS AND TECHNIQUES

**Accessory Instrumentation for the Scleral Buckling Operation**
*R. David Sudarsky, M.D., and Herbert M. Katzin, M.D., New York* ..... 503

## REGISTRY OF INTERESTING CASES

**Hereditary Changes in Skin of the Eyelids**
*Jesse M. Levitt, M.D., Brooklyn* ..... 506

## ANNUAL REVIEWS

**The Orbit**
*Frank C. Winter, M.D., Palo Alto, Calif.* ..... 508

## CORRESPONDENCE

**Evaluation of Absorbable Gelatin Film (Gelfilm) in Cyclodialysis Clefts**
*Joseph Laval, M.D.; Jules Yasuna, M.D.; Robert Coles, M.D., and Ira Eliasoph, M.D., New York* ..... 531
*D. Barsky, M.D., Wyandotte, Mich.* ..... 531

## OBITUARIES

**Watson Gailey, M.D.** ..... 532

## REGULAR DEPARTMENTS

**News and Comment** ..... 534
**Books** ..... 537

# A. M. A.
# ARCHIVES OF OPHTHALMOLOGY

Continuing the Publication
FOUNDED BY HERMAN KNAPP, 1869

VOLUME 62 SEPTEMBER 1959 NUMBER 3



COPYRIGHT, 1959, BY THE AMERICAN MEDICAL ASSOCIATION



Published under the Auspices of the Board of Trustees



EDITORIAL BOARD

FRANCIS HEED ADLER, Chief Editor
313 South Seventeenth Street, Philadelphia

W. L. BENEDICT, Rochester, Minn.
DAVID G. COGAN, Boston
JOHN H. DUNNINGTON, New York
MICHAEL J. HOGAN, San Francisco
WILLIAM F. HUGHES, Jr., Chicago
HAROLD G. SCHEIE, Philadelphia
KENNETH C. SWAN, Portland, Ore.

ASSOCIATES:

Crowell Beard
Bernard Becker
Webb P. Chamberlain
Leonard Christensen
Zacharias Dische
Robert W. Hollenhorst
Arthur Linksz
Donald J. Lyle
William Councilman Owens
Andrew de Roetth Jr.
Joseph A. C. Wadsworth
Frank C. Winter

J. F. HAMMOND, Editor, A. M. A. Scientific Publications
GILBERT S. COOPER, Managing Editor, Specialty Journals
T. F. RICH, Assistant Managing Editor, Specialty Journals



The A. M. A. Archives of Ophthalmology is published monthly by the American Medical Association and is an official publication of the Association.

Executive Vice President: F. J. L. BLASINGAME, M.D.
Business Manager: RUSSELL H. CLARK

ADVERTISING: Business Director, Russell H. Clark; Advertising Production Manager, Walter H. Kimotek. Advertising Representatives: Vernon J. Wendt, 535 North Dearborn Street, Chicago 10, Illinois, WHitehall 4-1500; Al Detwiller, 475 Fifth Avenue—Room 1005, New York 17, New York, ORegon 9-9383; Dale B. Clarke, 1919 Wilshire Blvd., Los Angeles 57, California, HUbbard 3-3811.

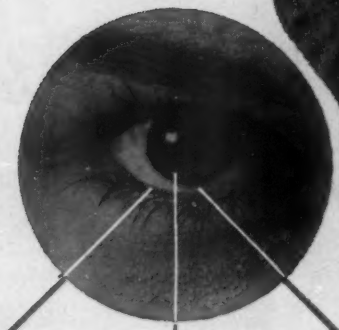
CIRCULATION: Circulation Manager, Robert A. Enlow; Assistant Circulation Manager, Bernard F. Kroeger. The yearly subscription rate of the Archives of Ophthalmology is: U. S. and Possessions, $12.00; Canada, $12.50. Other Foreign Countries $13.50. Special price to Students, Interns, and Residents in U. S. and Possessions, $7.00. Single copies of this and previous calendar year $1.25.

Back issues older than two years are available through Walter J. Johnson, Inc., 111 Fifth Avenue, New York 3, New York. Reprints of back issues available through Johnson Reprint Corporation, 111 Fifth Avenue, New York 3, New York.

**CHANGE OF ADDRESS: Please notify publisher at least six weeks in advance, including both old and new address, and mailing label taken from the most recent copy. Include your new Postal Zone number, if you live in a zoned city.**

Second-class postage paid in Nashville, Tennessee.

Please address communications and subscription orders to: American Medical Association, 535 North Dearborn Street, Chicago 10, Illinois.



common "outer eye" disorders

**allergic**
(allergic blepharitis, allergic conjunctivitis, episcleritis)

**inflammatory**
(acute catarrhal conjunctivitis, ulceration, meibomitis, keratitis)

**traumatic**
(foreign bodies, burns, abrasions, lacerations)

## consistently respond to topical therapy with

# METIMYD®

## ophthalmic suspension

**prednisolone 0.5% plus sulfacetamide sodium 10%**

## ointment with neomycin 0.25%

*Tissue destruction is halted, healing is set in motion* by the anti-inflammatory, antiallergic action of prednisolone and the antimicrobial property of sulfacetamide sodium combined in METIMYD Suspension...and for an even wider spectrum of antibacterial effectiveness, neomycin sulfate is added in METIMYD Ointment, the ointment form assuring sustained therapeutic action through the night.

Schering

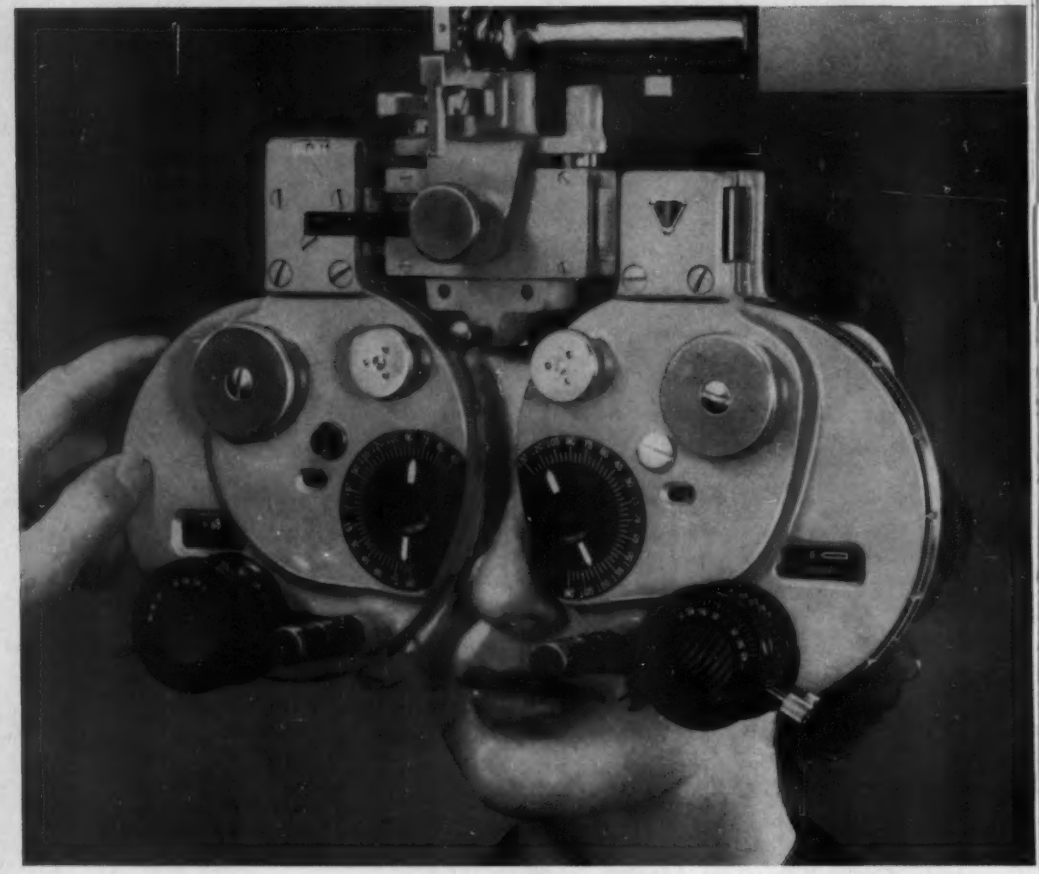
SCHERING CORPORATION • BLOOMFIELD, NEW JERSEY

MT-J-215

5/

B&L

True complement



Instrumentation

*to your professional skill*

**NOW MORE THAN EVER... THE KEY TO PRESCRIPTION ACCURACY** With super-scopic styling, the Bausch & Lomb Greens' Refractor provides unexcelled examining ease and prescription accuracy. You get greatly increased visibility, and smoother, swifter mechanical operation. Long recognized as a most efficient refractor, today's Greens' Refractor becomes a key aid to modern professional procedure.

For a demonstration in your office, call your Bausch & Lomb authorized ophthalmic instrument dealer, or write: Bausch & Lomb Optical Co., Dept. F-068, Rochester 2, New York.

**Greens' Refractor**

*by* BAUSCH & LOMB

## Instructions to Contributors

Articles, book reviews, and other materials for publication should be addressed to the Chief Editor. Articles are accepted for publication on condition that they are contributed solely to this journal.

An original typescript of an article, with one carbon copy, should be provided; it must be double or triple spaced on one side of a standard size page, with at least a 1-inch margin at each edge. Another carbon copy should be retained by the author.

**The main title of an article may not contain more than eighty characters and spaces;** a subtitle may be of any length.

The author's name should be accompanied by the highest earned academic or medical degree which he holds. If academic connections are given for one author of an article, such connections must be given for all other authors of the article who have such connections.

If it is necessary to publish a recognizable photograph of a person, the author should notify the publisher that permission to publish has been obtained from the subject himself if an adult, or from the parents or guardian if a child. An illustration that has been published in another publication should be accompanied by a statement that permission for reproduction has been obtained from the author and the original publisher.

Oversized original illustrations should be photographed and a print on glossy paper submitted. Prints of a bluish tinge should be avoided. Large photomicrograph prints will be reduced in scale unless portions to be cropped are indicated by the author. The author should submit duplicate prints of roentgenograms and photomicrographs with the essential parts that are to be emphasized circled, as a guide to the photoengraver.

Charts and drawings should be in black ink on hard, white paper. Lettering should be large enough, uniform, and sharp enough to permit necessary reduction. Glossy prints of x-rays are requested. Paper clips should not be used on prints, since their mark shows in reproduction, as does writing on the back of prints with hard lead pencil or stiff pen. Labels should be prepared and pasted to the back of each illustration showing its number, the author's name, and an abbreviated title of the article, and plainly indicating the top. Charts and illustrations must have descriptive legends, grouped on a separate sheet. Tables must have captions. ILLUSTRATIONS SHOULD BE UNMOUNTED.

References to the literature should be limited to those used by the author in preparation of the article. They should be typed on a special page at the end of the manuscript. The citation should include, in the order given, name of author, title of article (with subtitle), name of periodical, with volume, page, month—day of month if weekly or biweekly—and year. References to books must contain, in the order given, name of author, title of book, city of publication, name of publisher, and year of publication.

**AMERICAN MEDICAL ASSOCIATION**

**535 North Dearborn Street** **Chicago 10**

**When delineating CORNEAL INJURIES.**

**When making the FLUORESCEIN TEST to ascertain postoperative closure of the corneo-scleral wound in delayed anterior chamber reformation.**

**When determining the site of INTRAOCULAR INJURY.**

Each FLUOR I STRIP contains sufficient Fluorescein Sod. U.S.P. on a base of special lint-free paper . . . with stain-proof finger grips . . . to effectively stain the eye.

*Supplied:* Packages of 200 FLUOR I STRIPS

NOW DIVISION OF DOHO

*Literature available*

**FLUOR I STRIP**
*offers these advantages . . .*

**NO** risk from use of Fluorescein solutions exposed to contamination.

**NO** copious flushing to remove excess stain.

**NO** objectionable staining of patient's face or doctor's hands.

**NO** mercurial preservatives to sensitize patient.

**OPHTHALMOS, Inc.**
DIVISION OF DOHO
100 VARICK ST., NEW YORK 13, N. Y.

**It's new!**
**It's sensational!**
**It's the design of tomorrow!**

It's the...

# HAAG·STREIT
# *Slit·Lamp*
# "900"

In constant demand since introduced at the International Congress in Brussels, the all new Haag-Streit Slit-Lamp "900" can *now* be ordered through the House of Vision, Inc. The short time it will take you to order *now* can possibly save you months of waiting *later*. Orders are piling in. Our first allotment will soon be sold out.

*See it and other fine imported and quality American ophthalmic instruments—one of the most complete collections assembled anywhere—at the*

## Academy Meeting

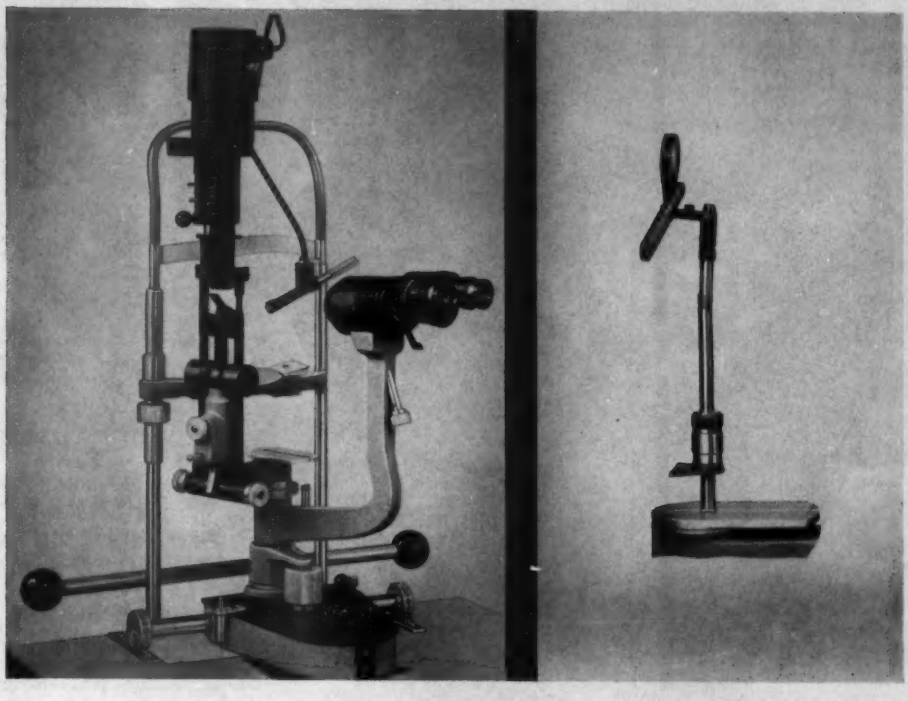
October 11th to 16th
Booths 65-68

*and in our Instrument Department at* The House of Vision Inc.

137 No. Wabash • Chicago 2, Illinois

# The House of Vision invites you to see the ALL NEW and improved

# HAAG·STREIT slit·lamp "900"



**The all new Haag-Streit Slit-Lamp "900" introduces pacesetting advancements in mechanical and optical design—all especially designed to facilitate the ophthalmologist's work.**

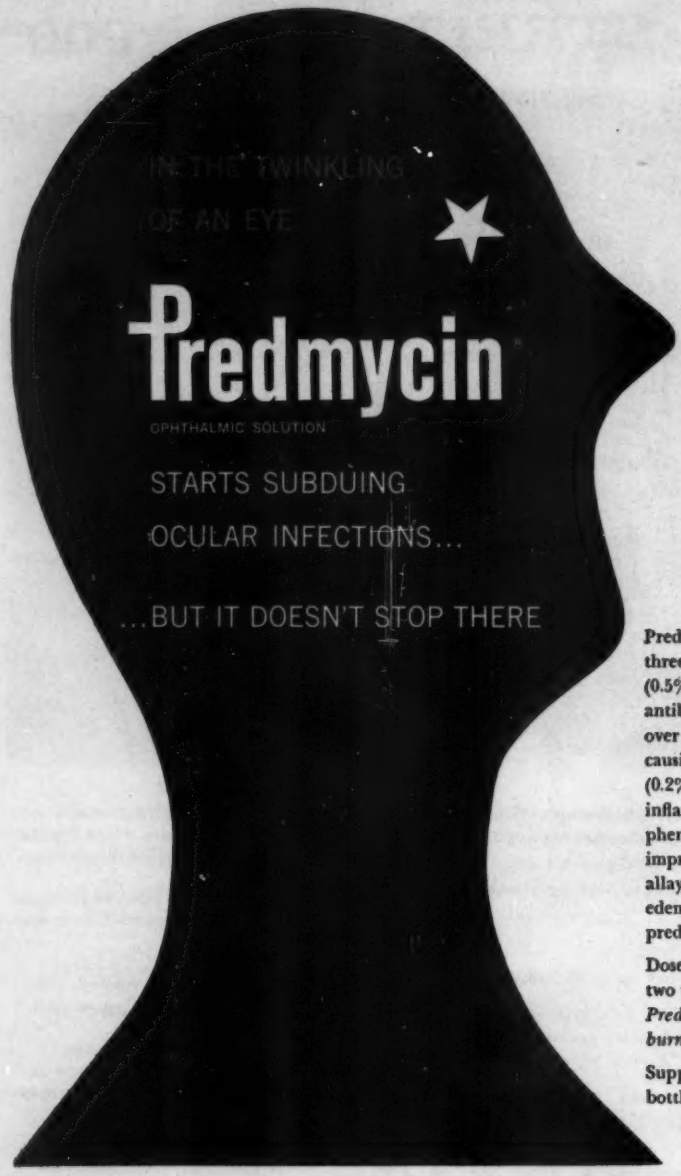
- Illumination is as much as twice as brilliant.
- New inclining device and rotatable slit let you get oblique, horizontal and vertical sections—no prisms or attachments needed.
- Extremely convenient dual controls—use either hand.
- New improved Hruby lens mounting—lens follows microscope movements while frontal distance of lens in relation to eye remains same.
- New design fixation lamp—always in focus to patient—eliminating accommodation and convergent movements.
- All important parts are self-adjusted, interchangeable units—permit ready use of accessories.
- Aplanation Tonometer can be attached and removed at will—no other adjustments necessary.

*Write for FREE illustrated, descriptive brochure.*

The House of Vision Inc.

137 No. Wabash • Chicago 2, Illinois

Your present Slit Lamp has a trade-in value at H.O.V.




**Predmycin offers unique, three-fold action: neomycin (0.5%) for prompt and potent antibacterial action against over 90% of ocular disease-causing organisms, prednisolone (0.2%) to check destructive inflammatory reactions, and phenylephrine (0.12%) to improve the eye's appearance, allay irritation, reduce edema and localize the prednisolone in the tissue.**

**Dose: 1-2 drops in the eyes, two to four times a day. *Predmycin does not sting or burn on administration.***

**Supply: 5 cc. plastic dropper bottles—on prescription only.**

**ALLERGAN CORPORATION** ***Los Angeles 17, California***

*New!*

# WELCH ALLYN RECHARGEABLE BATTERY HANDLES

**with desk or wall mounted charger**

- **Always fully charged in office use.** Place handles in charger when not in use and they recharge automatically. Can't overcharge.
- **Last as long as large conventional batteries,** without recharging, when used on house and hospital calls. Can be recharged thousands of times.
- **Handles are small and lightweight,** even smaller than WA medium (No. 705) handle.
- **Compact, attractive charger** takes only 7½" x 4" space on desk, or installs on wall bracket. Plugs into 110 v. AC outlet.
- **Handles have Permafit collar,** accept any WA instrument head.

WA No. 712 Two rechargeable handles with desk-type charger (less instrument heads) ..... $60.00

**WELCH ALLYN**

LIGHTS THE WAY

**SKANEATELES FALLS, NEW YORK**

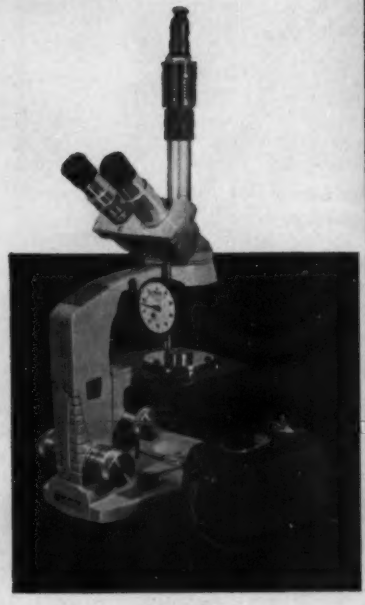
The microspherometer is one of the many instruments used to maintain quality control at The Plastic Contact Lens Company. After many years of research and development, this first practical binocular measuring device for accurately determining the base curves and surface qualities of contact lenses was devised. It is accurate to within .01 mm.

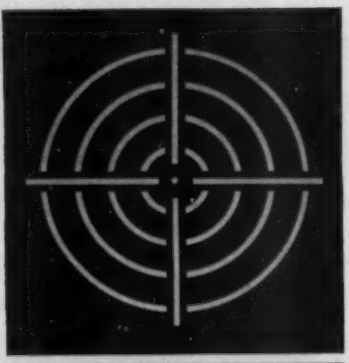
Although the term microspherometer usually refers to a mechanical method of measuring curvature, the instrument illustrated is a very fine optical device combining microscopic qualities with optical principles of measurement.

The photographs demonstrate the fine differences in surface quality between a perfect lens and a reject with the microspherometer, but not normally seen with the usual instrumentation for checking base curves. Such laboratory instrumentation for maintaining quality control is only one of the many developments of The Plastic Contact Lens Company used to offer you quality service in the field of contact lenses.

*quality control with*

# THE MICROSPHEROMETER





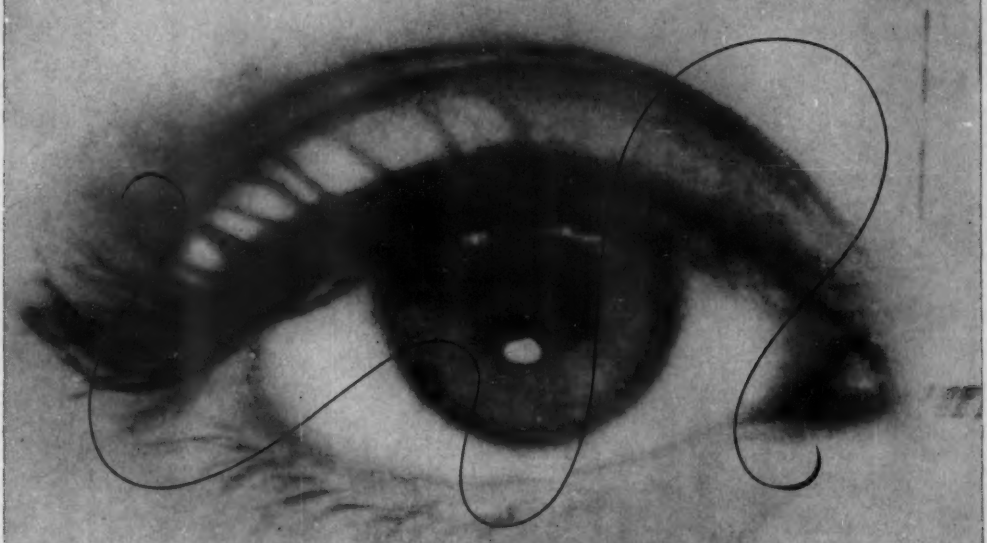
*THE PLASTIC* *CONTACT LENS COMPANY*

Knowledge—Research—Development for the Contact Lens Field

*59 East Madison Street*
*Chicago 3, Illinois*

# DESIGNED FOR YOUR MOST EXACTING REQUIREMENTS

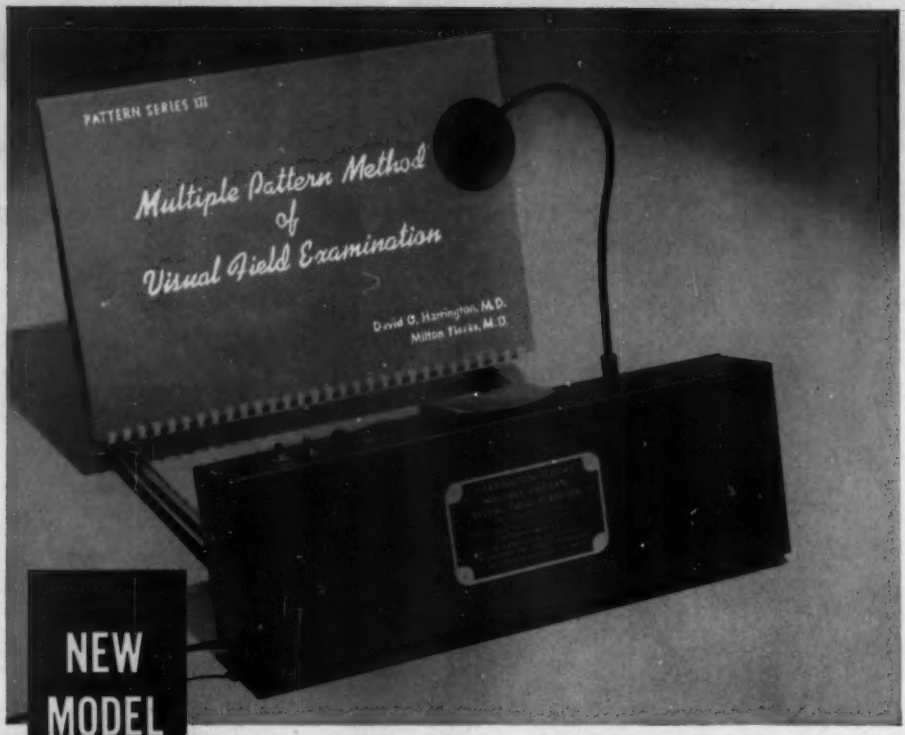
## ETHICON® OPHTHALMIC NEEDLE SUTURES



- hand-finished Micro-Point® needles
- unequaled sharpness by hand honing
- 40% greater strength
- increased stability in needle holder
- reduced tendency to cut out of tissue

**ETHICON EYE SUTURES with Tru-Tempered reverse cutting needles for maximum strength and minimum tendency to cut out of tissue.**

ETHICON®




NEW MODEL

# Harrington-Flocks Field Screener only $149.50

Introduced by Jenkel-Davidson in 1956, the Harrington-Flocks Visual Field Screener has become standard equipment in leading ophthalmologists' offices throughout the country.

This Screener has proved to be remarkably accurate—and you can easily test a patient in three to five minutes! No special instructions are needed. Just press a button activating the black light flashes. What the patient sees on the various test cards indicates any loss in visual field, signaling the necessity of further tests for glaucoma and other diseases.

**Order today—take advantage of this new low price.**

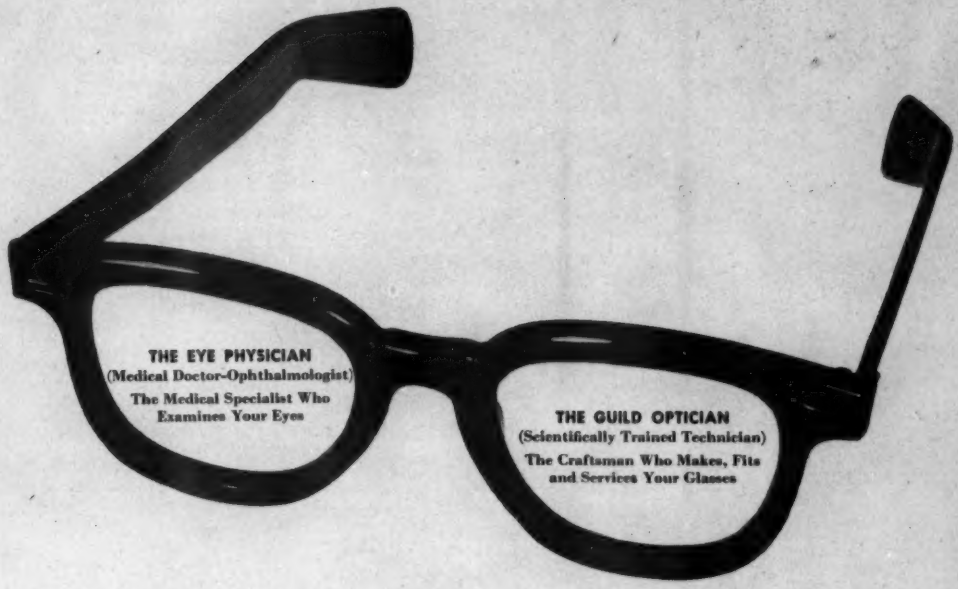
Satisfaction guaranteed. Write or wire collect

Jenkel-Davidson
OPTICAL COMPANY

366 Post Street • San Francisco, California

5524

# Rx for BETTER VISION


THE EYE PHYSICIAN
(Medical Doctor-Ophthalmologist)
The Medical Specialist Who Examines Your Eyes
THE GUILD OPTICIAN
(Scientifically Trained Technician)
The Craftsman Who Makes, Fits and Services Your Glasses

**Eye Examination**—by appointment with a physician who is a specialist (ophthalmologist) interested in your visual health and trained to understand and treat it in relation to your general health.

**Glasses Fitted**—at the patients convenience, and accurately, by a Guild Optician; whether traditional glasses or contact lenses, he will fit them in accord with the physician's prescription and provide after-care, as long as the glasses are worn.

# WE CAN SAY IT THIS SIMPLY . . .

The quality—the optical performance of a lens is determined by

- the knowledge and judgment represented in the computation of formulas for its different powers
- the care and skill with which the formulas are executed
- the standards of its inspection, and the integrity with which they are observed

We believe we have achieved results which are unsurpassed in the world

# YOU CAN SAY IT AS SIMPLY AS THIS . . .

"SHURON WIDESITE LENSES"

SHURON OPTICAL COMPANY

SHURON®

Geneva, N.Y.
Rochester, N.Y.

**NEW**

**for**

**enzymatic**

**zonulysis...**

**from the ophthalmic**

**research**

**laboratories**

**of Alcon**

# ZOLYSE™

*alpha-chymotrypsin with* BALANCED SALT SOLUTION, ALCON

## In CATARACT SURGERY

ZOLYSE (alpha-chymotrypsin with BALANCED SALT SOLUTION, ALCON) lyses the zonules, facilitates delivery of the lens and minimizes such dangers as capsular rupture, loss of vitreous, traumatic iridocyclitis and detachment of the retina.

The BALANCED SALT SOLUTION, ALCON, which is furnished as a diluent and for lavage purposes, "offers less cytotoxic effect to the intraocular tissues than does normal saline diluent."[1] "It has been recently demonstrated that frequent irrigation with saline results in swelling of the corneal stroma from alteration of the mucopolysaccharides of the cornea."[2]

ZOLYSE reduces operative and post-operative complications.

ZOLYSE is well tolerated in patients over 20.

Each ZOLYSE unit contains one vial of 750 units of lyophilized alpha-chymotrypsin and one 10 cc vial of BALANCED SALT SOLUTION, ALCON, as the diluent and for irrigating the eye.

[1]Girard, Louis J., and Neely, Wanda: "The Evaluation of Zolyse in Cataract Extraction", Research Report No. 11, Alcon Laboratories, Inc., 1959.

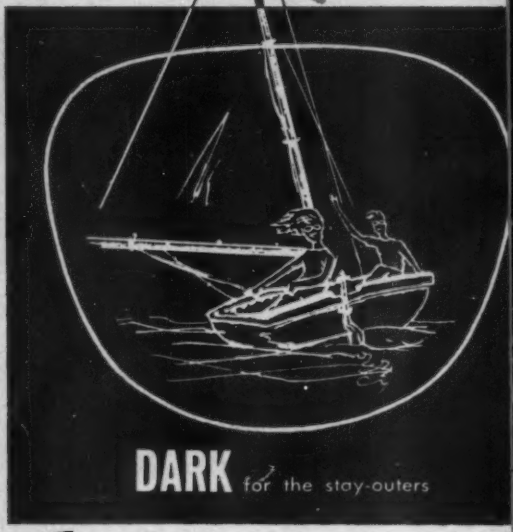
[2]Boyd, Benjamin F.: Enzymatic Zonulysis, Highlights of Ophth., vol. III, no. 4, pg. 70, 1959.

Alcon ALCON LABORATORIES, Inc.
FORT WORTH, TEXAS

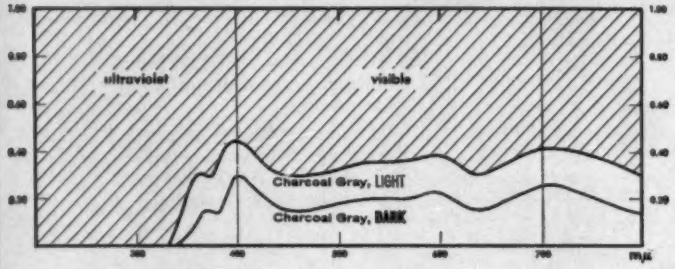
# For outdoor presbyopes 2 shades of MODERN

# Charcoal Gray

LIGHT for the in-and-outers



DARK for the stay-outers



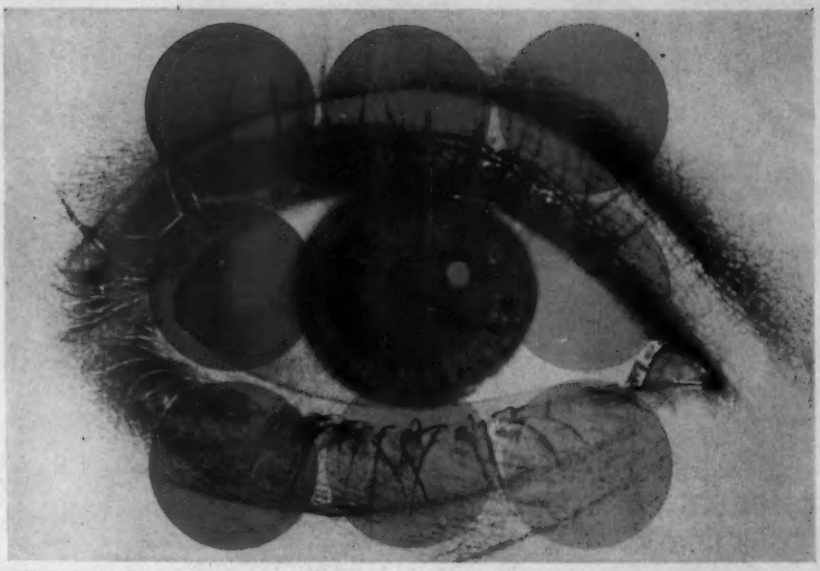

**Charcoal Gray, LIGHT = 37% total luminous transmission.**
Ideal for presbyopes who're in and out of the sun a great deal—salesmen, engineers, supervisors and service personnel, etc.

**Charcoal Gray, DARK = 19% total luminous transmission.**
Perfect for presbyopes who stay out in the sun for long periods—drivers, construction workers, boaters, golfers, hunters, fishermen, etc.

You can't give your patient a better, more effective neutral absorptive filter in a bifocal or 3-way than Modern's "Charcoal Gray—light" or "Charcoal Gray—dark." Both transmit near-normal color values . . . bar abiotic and erythemal ultra-violet. Both have neutral line, threshold-welded segs, manufactured under the industry's most rigid inspection system. Both come in Modern "B", Modern "D", and Mono-centric Seg 3-way, the uniformly top-quality multifocals made by . . .

3 fine MODERN lenses in 2 shades of Charcoal Gray

**MODERN OPTICS**
INCORPORATED
HOUSTON, TEXAS



# FOR EYES OF EVERY HUE... CYCLOGYL® FOR CYCLOPLEGIA

**NEW... FOR THE DARK BROWN OR BLACK IRIS... CYCLOGYL 2% WITH PVP**— the special soothing base containing PVP (polyvinylpyrrolidone) permits use of a higher concentration, effective even in the most darkly pigmented iris.

**FOR THE BROWN OR HAZEL IRIS... CYCLOGYL 1%**

**FOR THE BLUE, GRAY OR GREEN IRIS... CYCLOGYL 0.5%**

**VALUABLE TIMESAVING** – effective within 30 minutes – rapid recovery when a miotic is used.*

**MAXIMAL SAFETY** "... no significant variation of intraocular tension has been reported ... does not produce any undesirable local or systemic effects following repeated instillation... it is relatively nonirritating and nonsensitizing... animal studies show low toxicity..."[1]

**INDICATIONS:** Refraction. When both cycloplegia and mydriasis are desired in treatment of iritis, iridocyclitis, keratitis and choroiditis – preoperatively for cataract or other appropriate surgery. (Cyclomydril™ [Cyclogyl 0.2% with phenylephrine 1%] is indicated for diagnostic procedures and therapy requiring only mydriasis).

**AVAILABILITY:**

| | |
|---|---|
| New Cyclogyl 2% | 7.5 ml. dropper bottle, 2 ml. dropper bottle (prescription size) |
| Cyclogyl 1% | 15 ml. dropper bottle, 2 ml. dropper bottle (prescription size) |
| Cyclogyl 0.5% | 15 ml. dropper bottle |

**SAMPLES AND LITERATURE AVAILABLE ON REQUEST**

*When a miotic cannot be used, recovery occurs within 24 hours.

1. New and Nonofficial Drugs; J. B. Lippincott Company, Philadelphia, 1958, p. 243.

*Schieffelin & Co. / Since 1794*
Pharmaceutical and Research Laboratories
New York 3, N.Y.

**CYCLOGYL®**
(cyclopentolate hydrochloride, Schieffelin)

# 10 SPECIALTY JOURNALS

PUBLISHED MONTHLY
BY THE AMERICAN MEDICAL ASSOCIATION

**NEUROLOGY**

**GENERAL PSYCHIATRY**

**SURGERY**

**PATHOLOGY**

**DISEASES OF CHILDREN**

**OPHTHALMOLOGY**

**INDUSTRIAL HEALTH**

**DERMATOLOGY**

**INTERNAL MEDICINE**

**OTOLARYNGOLOGY**

Each journal offers the latest medical research and developments of outstanding specialists. Edited for the doctor by prominent authorities in each special field, these journals are of value not only to the specialist but to the general practitioner as well.

To order your subscription to one of the A.M.A.'s specialty journals use the form below.

**AMERICAN MEDICAL ASSOCIATION**
**535 North Dearborn • Chicago 10**

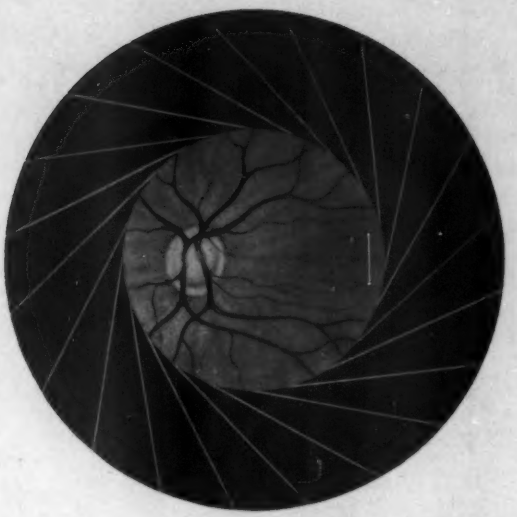
Please enter my subscription to the specialty journal checked at right.
Remittance for ☐ one year ☐ two years is enclosed.

NAME_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

| (One year rates) | U.S.A. & Possessions APO's | Canada | Outside U.S.A. & Possessions |
|---|---|---|---|
| ☐ A.M.A. Arch. Neurology ..... | $14.00 | $14.50 | $15.50 |
| ☐ A.M.A. Arch. Gen. Psychiatry . | $14.00 | $14.50 | $15.50 |
| ☐ A.M.A. Arch. Dermatology.... | 12.00 | 12.50 | 13.50 |
| ☐ A.M.A. Arch. Industrial Health. | 10.00 | 10.50 | 11.50 |
| ☐ A.M.A. Arch. Internal Medicine | 10.00 | 10.50 | 11.50 |
| ☐ A.M.A. Jrl. Diseases of Children | 12.00 | 12.50 | 13.50 |
| ☐ A.M.A. Arch. Surgery ..... | 14.00 | 14.50 | 15.50 |
| ☐ A.M.A. Arch. Pathology ..... | 10.00 | 10.50 | 11.50 |
| ☐ A.M.A. Arch. Ophthalmology.. | 12.00 | 12.50 | 13.50 |
| ☐ A.M.A. Arch. Otolaryngology.. | 14.00 | 14.50 | 15.50 |



# NOW...DISTINCT FUNDUSCOPIC OBSERVATIONS
# CYCLOMYDRIL™...FOR MYDRIASIS
# FAST...PROFOUND...WITHOUT CYCLOPLEGIA

...ive—through the use of New CYCLOMYDRIL.™ Even in the most darkly pigmented iris, a dramatic pupillary dilation begins upon instillation. This profound mydriasis is resistant to bright light *but readily reversible in an hour or less with a miotic.*

Mean Increase in Pupil Size 30 Minutes after Instillation[1]

| | |
|---|---|
| brown or hazel eyes | 3.15 mm. |
| dark brown (Negro) eyes | 3.50 mm. |
| blue, gray or green eyes | 4.38 mm. |

The combined action of phenylephrine—an adrenergic mydriatic of choice[2] and Cyclogyl®—a potent anticholinergic mydriatic (in a concentration without cycloplegic effects) produces a pupillary dilation greater than that obtained by either drug alone. Cyclomydril is well tolerated—no significant change in ocular tension or other serious side effects.

***Indications and Dosage:*** In funduscopy—one drop in each eye.
In treatment of iritis, iridocyclitis, keratitis, choroiditis, posterior synechiae, ocular trauma and after removal of cataracts or other ocular surgery—one drop every 6-8 hours.
May be used for refraction in certain patients who have little or no accommodation. (Cyclogyl® is required when both cycloplegia and mydriasis are indicated.)

***Composition:*** Cyclogyl® (cyclopentolate hydrochloride) 0.2%, phenylephrine hydrochloride 1.0% with PVP (polyvinylpyrrolidone) in a sterile, buffered ophthalmic solution. Available in 2 ml. and 7.5 ml. dropper bottles.

***Samples and literature available on request.***

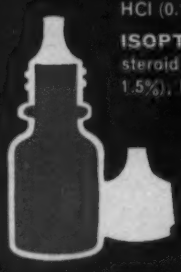
1. Priestley, B. S.; Medine, M. M., and Phillips, C. C. To be published. 2. Ahlquist, R. P. In Drill, V. A.: Pharmacology in Medicine, McGraw-Hill Book Company, Inc. New York, 1954, p. 18-26.

Pharmaceuticals | Since 1794 CYCLOMYDRIL®

## ANTIBIOTICS? ANTIBIOTIC-STEROIDS? STEROIDS?

All Alcon antibiotics/steroids have these advantages: they contain Methylcellulose, a chemically inert vehicle that holds drugs in contact with the eye 6 to 8 times longer than simple aqueous solutions and serves as a soothing, comfortable lubricant . . . tonicity and pH adjustments to assure optimum patient comfort and maximum therapeutic effectiveness . . . sterile 5 cc. Drop-Tainer® packaging reduces the likelihood of contamination during use . . . preservatives added.

# Whatever your decision— a product of choice



**ISOPTO® P-N-P** for common, mildly inflammatory, external ocular infections; contains Polymyxin B Sulfate (16,250 units/cc.), Neomycin Sulfate (5 mg./cc.), Phenylephrine HCl (0.12%), and Methylcellulose (0.5%).

**ISOPTO® P-H-N** for less common, severely inflammatory ocular infections that require steroid therapy; contains Polymyxin B Sulfate (16,250 units/cc.), Hydrocortisone (0.5% or 1.5%), Neomycin Sulfate (5 mg./cc.), Methylcellulose (0.5%).

**ISOPTO® HYDROCORTISONE** for inflammatory ocular lesions in the absence of bacterial or virus infections; contains Hydrocortisone (0.5% or 2.5%) and Methylcellulose (0.5%). *Also available:* Isopto® Cortisone (0.5% or 2.5%).

**ISOPTO® STEROFRIN** for ocular allergies or other inflammatory conditions in the absence of infection; contains Hydrocortisone (0.5%), Phenylephrine HCl (0.12%), and Methylcellulose (0.5%).

*Available at prescription pharmacies throughout the United States and Canada*

Alcon **ALCON LABORATORIES, INC. • FORT WORTH, TEXAS**

A.M.A. ARCHIVES OF
OPHTHALMOLOGY

# Urea as an Osmotic Ocular Hypotensive Agent in Glaucoma

MILES A. GALIN, M.D.; FUTABA AIZAWA, M.D., and JOHN M. McLEAN, M.D., New York

The ophthalmologist has available three distinct medical methods to reduce intraocular pressure: improvement of the facility of aqueous outflow; reduction of aqueous inflow, and reduction of ocular volume through the use of osmotic (hypertonic) agents. The first two methods are well known and are used extensively. The third is seldom used and then usually under urgent circumstances and with poor results. However, the osmotic method is theoretically so valuable that if an ideal agent for its application were available, it would be employed with greater frequency, under a greater variety of conditions, and with more success. An agent approaching this ideal is urea.

Though osmotic agents for reduction of intraocular pressure are infrequently used, they have a long history in ophthalmology and their mechanism of action is fairly well known. Hertel[1] did extensive studies with a variety of osmotic agents and showed that intraocular pressure could be elevated with hypotonic or reduced with hypertonic agents. He demonstrated that the reduction in tension produced by hypertonic solutions was due to a reduction in water content of the eyes. Duke-Elder[2] stated that the intraocular pressure could be reduced with hypertonic saline and only minimally altered with isosmotic solutions, clearly indicating that osmosis was the mechanism responsible for the effect. Fremont-Smith[3] reported that "changes of osmotic pressure induced in the blood produce a parallel change in pressure in the eye . . ." Accurate studies of a similar nature, with calculations of the plasma sodium excess and relative aqueous deficiency of sodium, have been done by Davson and Thomassen.[4]

However, the use of the osmotic method for reduction of intraocular pressure did not become clinically well known in this country until the introduction of sucrose as the osmotic agent. Saline solutions as well as dextrose had been used, but because of their rapid penetration into all tissues, including the eye, a high and sustained osmotic gradient could not be established. Sucrose, a poorly diffusible disaccharide, seemed applicable. Dyar and Matthew,[5] as well as Bellows et al.,[6] reported on its utilization. However, evidence of renal toxicity was soon reported,[7,8] and a search for a safer and more efficacious drug was undertaken. Sorbitol was introduced by Bellows et al.,[6] who reported excellent results with it. However, some of their data have been questioned by de Roetth,[9] and evidence of toxicity also has been noted.[8]

The use of drugs, such as sucrose and sorbitol, aside from toxic limitations has one major disadvantage. Their large molecular weights make it necessary to administer

Submitted for publication June 2, 1959.

These studies were supported in part by a grant from the National Council to Combat Blindness.

From the Department of Surgery (Ophthalmology) of The New York Hospital-Cornell Medical Center.

enormous doses to achieve a high osmotic level in the blood. A solution of sodium chloride, on the other hand, is excellent with respect to molecular size but has the deficiency of rapid and complete ocular penetration. This reduces the ability to obtain a sustained hypertonicity of the fluids of the body with respect to the eye.

Theoretically, therefore, an ideal osmotic agent for the reduction of intraocular pressure should be small in molecular size, be nontoxic, and have a relatively poor ocular penetrance. Such an agent is urea.

The following report describes our experiences during the past year in evaluating urea as a therapeutic agent in all types of glaucoma. Further experiences in assaying both intravenous and oral urea in the treatment of those conditions in which hypotony and reduction of volume would be desirable, such as central retinal artery occlusion, exophthalmos, and retinal detachment surgery, will be described in subsequent communications.

## Materials and Methods

Patients were obtained from the glaucoma clinic of The New York Hospital, as well as from the practices of several private ophthalmologists who referred patients with acute glaucoma who had not responded to miotics, acetazolamide (Diamox), and retrobulbar anesthesia.

The following routine was followed on all patients. Blood was obtained for subsequent analysis of freezing-point depression and of urea nitrogen. Tonography was performed, and shortly thereafter an intravenous infusion of 30% lyophilized,

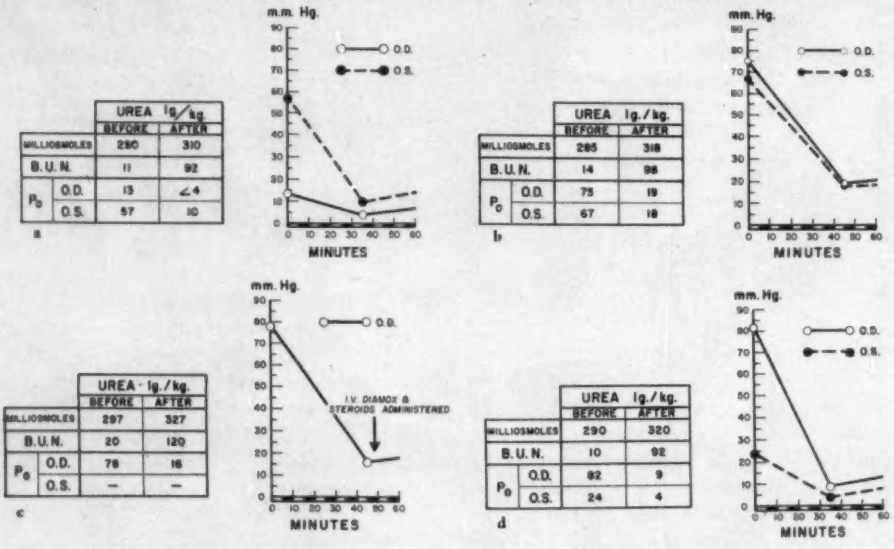



Fig. 1.—Effect of intravenous urea on intraocular pressure in various types of glaucoma. *a*, 55-year-old man, angle-closure glaucoma (during attack); *b*, 73-year-old woman, advanced open-angle glaucoma; *c*, 61-year-old man, uniocular patient with secondary glaucoma and renal disease; *d*, 50-year-old woman, secondary glaucoma (Boeck's sarcoid); *e*, 26-year-old man, congenital glaucoma.

ammonia-free urea * in 10% invert sugar was administered at the rate of about 3 to 5 cc. per minute. The total dose of urea was 1 gm. per kilogram of body weight. Serial tonographic tracings were obtained, as well as blood samples at appropriate intervals for repetition of the base-line studies. Urine was obtained from all patients and tested for the presence of hemoglobin.

## Results

Thirty-five patients with glaucoma have been studied. The results herein reported deal with ten consecutive, unselected cases involving various types and stages of glaucoma. These illustrative results are typical of those obtained in all patients thus far treated with urea. A table and graph, summarizing the pertinent data for each case, are shown in Figures 1 and 2.

It should be noted that dramatic reductions in intraocular pressure are usually obtained between 30 and 45 minutes from the inception of the urea infusion. At this time the blood osmolality has reached its maximum, and the ocular pressure response corresponds linearly to the blood osmolality. For the sake of conciseness, the graphs are not extended to include time intervals following the maximal hypotensive effect. However, the intraocular tension reaches the pretreatment level in about five hours.

* Kindly supplied by Abbott Laboratories, North Chicago, Ill.

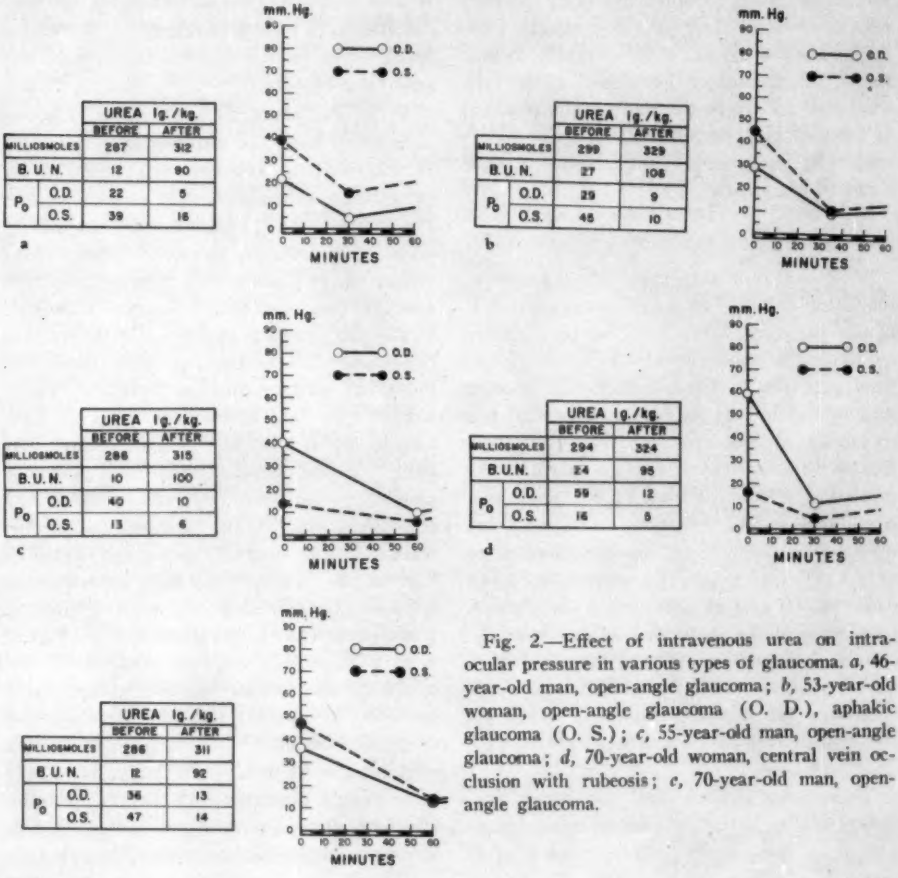



Fig. 2.—Effect of intravenous urea on intraocular pressure in various types of glaucoma. *a*, 46-year-old man, open-angle glaucoma; *b*, 53-year-old woman, open-angle glaucoma (O. D.), aphakic glaucoma (O. S.); *c*, 55-year-old man, open-angle glaucoma; *d*, 70-year-old woman, central vein occlusion with rubeosis; *e*, 70-year-old man, open-angle glaucoma.

*Comparison of Osmotic Potentials of Equal Weights of Various Agents* *

| Substance | Formula | Molecular Wt. | MOsm/70 Gm. Substance | MOsm/L. Body Water |
|---|---|---|---|---|
| Urea | $NH_2CONH_2$ | 60.06 | 1165.5 | 27.75 |
| Sucrose | $C_{12}H_{22}O_{11}$ | 342.30 | 204.52 | 4.87 |
| D-Sorbitol | $C_6H_{14}O_6 \cdot \frac{1}{2}H_2O$ | 191.18 | 366.15 | 8.72 |
| D-Glucose (anhydrous) | $C_6H_{12}O_6$ | 180.16 | 388.54 | 9.25 |
| D-Glucose | $C_6H_{12}O_6 \cdot H_2O$ | 198.17 | | |

* The last column represents the theoretically obtainable milliosmole change per liter of body water (assuming total body water diffusion) from administration of 70 gm. of each substance.

The blood urea nitrogen and blood osmolality are normal within 24 hours. Urinary hemoglobin has not been found in any patient.

The nature of the patient's glaucoma in no way influences the osmotic response. Even in refractory angle-closure glaucoma, the rapid and profound hypotony permits miotics to exert their pupillary effects. Consequently, the closure cycle is rapidly terminated. In secondary glaucoma, as will be discussed subsequently, the osmotic gradient is reduced and the return to original hypertensive levels is more rapid than in the other types of glaucoma.

## Comment

It is apparent that urea has a truly remarkable osmotic effect in lowering intraocular pressure. Urea has also been shown to have the same effect on cerebrospinal fluid pressure.[10] Theoretically, this is quite understandable. Urea has a relatively low molecular weight, particularly when contrasted to a substance such as sucrose. The molecular weight of urea is 60, while that of sucrose is 342. Solutions of sucrose and urea of similar weight concentrations have very different osmotic potentials. For example, 70 gm. of urea, the dose administered to a 70 kg. patient, contains approximately 1,165 mosm. The same weight of sucrose contains only 204 mosm. The Table compares the osmotic potentials based on concentration between sucrose, sorbitol, glucose, and urea.

There is a definite and consistent deficiency of urea in the aqueous as compared to plasma, a fact clearly demonstrated by Adler.[11] This indicates that a potential osmotic gradient exists, though no attempt has been made in this study to determine if the plasma-to-aqueous gradient is markedly altered at high blood levels of urea. However, it has been demonstrated[12] that this gradient is lost when the blood-aqueous barrier is broken down. This fact probably accounts for the rapid return to original hypertensive levels when urea is utilized in cases of secondary glaucoma.

When compared as to the rates at which substances enter the anterior chamber, urea is intermediate between the very slowly penetrating substances, such as sucrose, and the more rapidly penetrating substances, such as sodium or glucose.[12] Sucrose, a rather large molecule, enters the eye through the intercullular spaces. However, size is not the only factor which determines penetrance, as sucrose is only twice the molecular size of glucose though its penetrance into the anterior chamber is one-eighth that of glucose.[12] Davson states that urea "in the plasma diffuses sufficiently slowly into the secretory cells of the ciliary epithelium, that it fails to achieve a concentration in the primary secretion equal to that in the plasma; the fluid entering the anterior chamber thus has a lower concentration than that in the plasma. . . ." Figure 3 is a schematic diagram contrasting the ocular penetrance of sucrose, glucose, and urea. It is apparent that the high osmolal concentration is the major factor for the effectiveness of urea. Javid and Anderson[13] have clearly demonstrated that the diuretic effect of urea is not related to its effect in lowering intracranial pressure. Though sim-

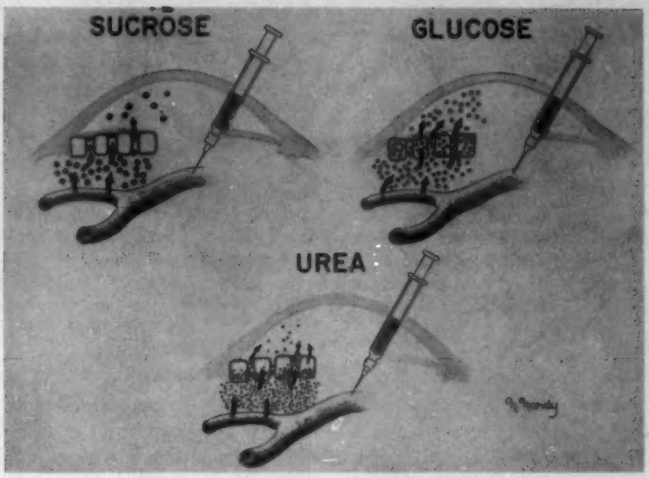



Fig. 3.—Schematic comparison of ocular penetrance of various agents with respect to osmotic effect.

ilar studies have not been done with respect to intraocular pressure, it is reasonable to assume that the mechanism is similar.

Urea distributes rapidly throughout the body water and, in fact, can be used as a measure of body water. It is very simple, therefore, to calculate the theoretically obtainable osmolal change from intravenously administered urea. If we again use our theoretical 70 kg. man and assume a total body water of 60%, then the number of milliosmoles per liter of body water that is administered with a dosage level of 1 gm. of urea per kilogram is approximately 28. This is in close agreement with the maximal osmolal change as measured by freezing-point depressions that have been obtained, as has been indicated in Figures 1 and 2.

Lastly, it is important to realize that urea is an extremely safe drug. The only factor limiting its use is the ability of the patient to sustain a very pronounced osmolality change. When necessary, we have given it to patients with renal disease and have experienced no complications. However, as with all potent methods of therapy, careful evaluation of each case is mandatory.

## Summary

The use of urea as an agent for the osmotic reduction of intraocular pressure is described. The results of its use in all types of glaucoma are presented. In a dosage level of 1 gm. per kilogram intravenously administered as a 30% solution in 10% invert sugar, urea induces marked ocular hypotony in approximately 30 to 45 minutes. The hypotensive change is directly proportional to the altered (increased) blood osmolality, as measured by freezing-point depression determinations. The low molecular weight of urea, relatively poor ocular penetrability, and safety make it an excellent agent for this purpose.

525 E. 68th St. (21).

## REFERENCES

1. Hertel, E.: Experimentelle Untersuchungen über die Abhängigkeit des Augendrucks von der Blutbeschaffenheit, von Graefes Arch. Ophth. 88: 197, 1914.

2. Duke-Elder, W. S.: The Reaction of the Intra-Ocular Pressure to Osmotic Variation in the Blood, Brit. J. Ophth. 10:1, 1926.

3. Fremont-Smith, F., and Forbes, H. S.: Intra-Ocular and Intracranial Pressure: An Experimental Study, Arch. Neurol. & Psychiat. 18: 550, 1927.

4. Davson, H., and Thomassen, T. L.: The Effect of Intravenous Infusion of Hypertonic Saline on the Intra-Ocular Pressure, Brit. J. Ophth. 34:355, 1950.

5. Dyar, E. W., and Matthew, W. B.: Use of Sucrose Preparatory to Surgical Treatment of

Glaucoma: A Preliminary Report, Arch. Ophth. 18:57, 1937.

6. Bellows, J.; Puntenney, J., and Cowen, J.: Use of Sorbitol in Glaucoma, Arch. Ophth. 20: 1036, 1938.

7. Helmholtz, H. F.: Renal Changes in Rabbits Resulting from Hypertonic Solution of Sucrose, J. Pediat. 3:144, 1933.

8. Lindberg, H. A.; Wald, M. H., and Barker, M. H.: Renal Changes Following Administration of Hypertonic Solution (50 Per Cent Sucrose, 50 Per Cent D-Sorbitol, 50 Per Cent Dextrose, and 10 Per Cent Sodium Chloride), Arch. Int. Med. 63:907, 1939.

9. de Roetth, A., Jr.: Effect of Changes in Osmotic Pressure of Blood on Aqueous Humor Dynamics, A. M. A. Arch. Ophth. 52:571, 1954.

10. Javid, M.: Urea: New Use of an Old Agent, S. Clin. North America, August, 1958, p. 1.

11. Adler, F. H.: Is the Aqueous Humor a Dialysate? Arch. Ophth. 10:11, 1933.

12. Davson, H.: Physiology of the Ocular and Cerebrospinal Fluids, Boston, Little, Brown & Company, 1956.

13. Javid, M., and Anderson, J.: The Effect of Urea on Cerebrospinal Fluid Pressure in Monkeys Before and After Bilateral Nephrectomy, J. Lab. & Clin. Med. 53:484, 1959.

# Parallel Retinal Folds

## *Their Significance in Orbital Space-Taking Lesions*

THOMAS R. HEDGES Jr., M.D., and IRVING H. LEOPOLD, M.D., Philadelphia

Retinal folds have been reported in the past in association with orbital tumors [1-3,5,6] and in exophthalmos due to thyroid disease.[3,7]

It is our purpose to present two patients from our private and clinic service who demonstrated this clinical finding. One had exophthalmos due to fibrous dysplasia and the other metastatic hypernephroma of the orbit.

The parallel folds described are produced by deformation of the globe where the expanding retrobulbar mass indents the sclera. The appearance of such folds may precede the proptosis [6] and give rise to hyperopia and astigmatism of varying degrees which may or may not be correctible with lenses.[1,3,5]

Ophthalmoscopic examination reveals horizontally parallel dark lines or folds in the posterior pole of the fundus usually running above and below the macula toward the disc. Birch-Hirschfield [1] first described these folds in a patient with sarcoma of the orbit where the wrinkling of the retina remained seven months after surgery. Drawings have been published by Walsh [7] and Reese.[8]

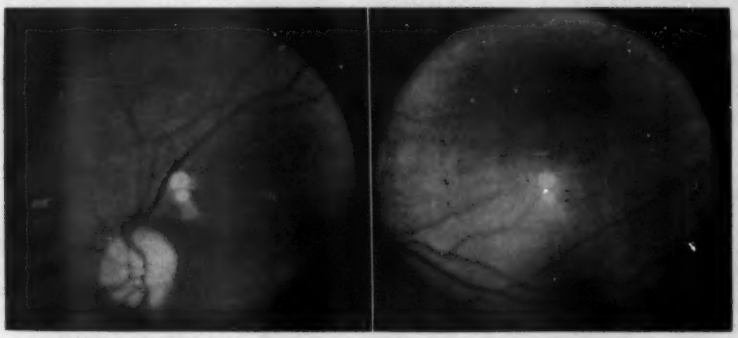
Reese points out that these folds may first take the form of tension lines produced by wrinkling of the internal limiting membrane of the retina. These tension lines radiate from the point where the tumor is in contact with the sclera.

It has been demonstrated pathologically by Birch-Hirschfield that these folds are actually infoldings of the retina. Kugelberg,[4] who observed such wrinkles or folds in a patient with exophthalmic goiter, felt that two forms exist, one involving all retinal layers, appearing as true folds, and the other, more early and less advanced striations involving the inner retinal layer as described by Reese.

These retinal folds should not be confused with similar lines and folds seen in various fundus lesions which follow the retinal architecture or are related to inflammatory or degenerative chorioretinal pathology.

Submitted for publication Feb. 6, 1959.

Fundus photographs of broad dark parallel retinal folds seen in the posterior pole of the left eye.



## Report of Cases

CASE 1.—A 52-year-old white woman developed distortion of the maxillary bone on the left over a nine-year period which, when biopsied in the early stages of its development, proved to be fibrous dysplasia. For two years gradual proptosis developed on the left, and then over a period of four to six months before operation vision was reduced to 1/60 with the visual field constricted to a small nasal island. At this time, ophthalmoscopic examination showed diffuse pallor of the nerve on the left. In addition, broad, dark parallel retinal folds were noted in the posterior pole of the left fundus. These folds or corrugations ran horizontally from the disc to the macula. A Kronlein operation was performed, and much tumor material was removed from the orbit up to the immediate retrobulbar space, which proved to be typical fibrous dysplasia. Postoperative convalescence was uneventful except for transient paresis of the external rectus muscle. Vision returned to 6/9 and the visual field widened to near normal limits within six weeks. The retinal folds remained unchanged when last seen four months after surgery.

CASE 2.—A 53-year-old Negro man developed exophthalmos of the left eye during a four-month period, with diplopia and retro-orbital pain. Examination revealed noncongestive exophthalmos of 4-5 mm. and weakness of the left lateral, superior, and inferior rectus muscles. Vision was normal, and there was indentation of the upper outer quadrant of the left visual field. Examination of the fundus showed normal findings except for linear horizontal parallel lines in the retina below the disc, which were approximately 2 D. D. in length and appeared much like striae, although they did not follow the distribution of the normal retinal pattern. Skull x-rays were normal. Thorough study uncovered a nodular type of infiltration in both lung fields suggestive of metastatic malignancy or sarcoid. An intravenous urogram uncovered a mass lesion in the pelvis of the right kidney, confirmed on retrograde pyelogram. The urologist requested that an attempt be made to get a biopsy specimen from the orbit rather than through an abdominal exploration.

Nine months later, during which time the patient remained in good general health, he returned with marked increase in proptosis. He now had broad, dark, parallel retinal folds in the posterior pole of the fundus, which ran more obliquely horizontal and were less regular than those noted in Case 1. Permission was granted for orbital exploration through a Kronlein incision, which revealed a diffuse tumor throughout the muscle cone and posterior orbit, much of which was removed. The pathology of this tumor was typical of a clear-cell carcinoma (hypernephroma) of the kidney.

## Summary

Two cases are presented with parallel retinal folds associated with exophthalmos due to orbital tumor. Retro-orbital extension of fibrous dysplasia from the maxillary bone accounted for this finding in one instance, and in the other a metastatic orbital expanding lesion from hypernephroma of the kidney produced unilateral exophthalmos and the parallel folds in the retina. The literature on this subject is reviewed, and it would appear that dark, broad, parallel folds or corrugations are the most typical and authentic signs reflecting direct pressure on the globe from an expanding lesion in the immediate retrobulbar area. In the two patients reported here, plus five others described in the literature to date, the exophthalmos and retinal folds were due to orbital tumor. However, in two reports similar findings were described associated with thyroid disease so that the sign, although suggestive, may not be interpreted as absolute evidence of retro-orbital tumor.

1711 Rittenhouse Sq. (3).

## REFERENCES

1. Birch-Hirshfeld, A.: Die Krankheiten der Orbita, in Handbuch der gesamten Augenheilkunde, edited by T. Graefe and T. Saemisch, Berlin, Springer-Verlag, 1930, Vol. 9.

2. Lohlein, W.: Über Faltenbildung in der Netzhaut durch Druck auf den Bulbus, Klin. Monatsbl. Augenh. 79:769-778, 1927.

3. Kugelberg, I.: "Rillenbildung" in der Retina als Ausdruck einer Deformation des hinteren Bulbusabschnittes, Klin. Monatsbl. Augenh. 89:171-183, 1932.

4. Blegvad, O.: Myxoma of the Orbit, Acta ophth. 22:131-140, 1944.

5. Kubik, J.: Die Folgen der Bulbuskompression bei Raumbeengung in der Orbita, Klin. Monatsbl. Augenh. 80:513-518, 1928.

6. Thiel, R.: Atlas der Augenkrankheiten, Leipzig, VEB Georg Thieme, 1937.

7. Forrest, A. W.: Intraorbital Tumors, Arch. Ophth. 41:198-232, 1949.

8. Reese, A. B.: Tumors of the Eye, New York, Paul B. Hoeber, Inc. (medical book department of Harper & Brothers), 1951, p. 515.

9. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, The C. V. Mosby Company, 1947, Vol. 3, pp. 2864-2926.

10. Walsh, F. B.: Clinical Neuro-Ophthalmology, Ed. 2, Baltimore, The Williams & Wilkins Company, 1957, p. 952.

# Postmortem Chemistry of the Vitreous Body in Man

**HANS N. NAUMANN, M.D., Memphis**

While there is information on the chemistry of the vitreous body (VB) in various animals,[1-12,14,15,24-29,31] reports on chemical constituents of the human VB are virtually nonexistent except for a few data on enucleated eyes.[3,16] Since material from human eyes during life is not available, it was thought of interest to investigate the VB of human cadavers in the course of studies on postmortem chemistry.[19-23]

## Materials and Methods

Autopsies performed on 211 male bodies of an average age of 58 years examined about nine hours after death on the average were selected on the basis of minimum pathology or changes unrelated to the metabolism of substances under investigation. About 2 to 5 ml. of VB pooled from both eyes were obtained at time of autopsy by a 10 cc. syringe and 20 gauge needle through puncture of the eyeball at the external canthus. Cerebrospinal fluid (CSF) was removed as previously described[19-21] by cisternal puncture and left heart blood from the left ventricle, atrium, or the pulmonary veins. The following standard procedures were performed: Folin-Wu's method for glucose,[13] direct nesslerization for urea,[18] Folin-Wu's method for creatinine,[13] Van Slyke-Hiller's modification of Sendroy's method and partly Schales and Schales' method for chlorine,[13] Fiske-Subarow's method for inorganic phosphorus,[13] Clark-Collip's method for calcium,[13] and flame photometry for sodium and potassium with the Perkin-Elmer apparatus[17] and partly with the Coleman apparatus.[30]

Submitted for publication Jan. 26, 1959.

From the Biochemistry Section, Kennedy Veterans Administration Medical Teaching Group Hospital.

TABLE 1.—*Postmortem and Comparative Antemortem Chemistry of Vitreous Body, Cerebrospinal Fluid, and Left Heart Blood*

| | Vitreous Body | Cerebrospinal Fluid[21,22] | | Blood[21] | |
|---|---|---|---|---|---|
| | | | | Left Heart | Venous Blood |
| | Post Mortem | Post Mortem | Ante Mortem | Post Mortem | Ante Mortem |
| Glucose, | 62 | 40 | 65 | 67 | 90 |
| mg/100 ml. | 17-105 | 13-94 | 40-90 | 20-344 | 70-110 |
| Urea, | 79 | 89 | 14 | 102 | 26 |
| mg/100 ml. | 24-172 | 8-197 | 8-28 | 27-165 | 17-32 |
| Creatinine, | 1.2 | 2.4 | 1.1 | 3.0 | 1.5 |
| mg/100 ml. | 0.3-3.0 | 0.9-3.6 | 0.5-1.2 | 1.6-4.1 | 1.0-2.0 |
| Chlorine, | 114 | 113 | 125 | — | — |
| mEq/L. | 89-145 | 89-142 | 119-128 | | |
| Phosphorus, | 1.2 | 5.2 | 0.8 | — | — |
| mEq/L. | 0.1-3.3 | 0.7-10.5 | 0.5-1.2 | | |
| Sodium, | 144 | 127 | 143 | — | — |
| mEq/L. | 118-154 | 107-150 | 134-152 | | |
| Potassium, | 7.7 | 21 | 2.9 | — | — |
| mEq/L. | 3.3-12 | 5.6-40 | 2.5-3.7 | | |
| Calcium, | 3.6 | 2.4 | 2.5 | — | — |
| mEq/L. | 2.8-5.2 | 1.9-3.4 | 2.3-2.6 | | |

## Results

A comparison of postmortem values in VB and CSF as given in Table 1 showed that the average value of glucose in VB, 62 mg/100 ml., was considerably higher than that in CSF, 40 mg/100 ml., and about as high as antemortem values in CSF, 65 mg/100 ml. The VB urea of 79 mg/100 ml. showed the same phenomenon of postmortem rise found in CSF and blood but to a slightly lower degree. The VB creatinine of 1.2 mg/100 ml. was half that found in CSF. Of cations the VB sodium of 144 mEq. per liter was higher than the CSF sodium of 127 mEq. per liter previously found to present a moderate deficit.[23] Potassium, on the other hand, was lower in VB, 7.7 mEq. per liter, as compared to the markedly increased value in CSF, 21 mEq. per liter. Calcium was 3.6 mEq. per liter in VB, one-half time higher than in CSF, 2.4 mEq. per liter.

TABLE 2.—*Comparative Chemistry of Vitreous Body in Man and in Animals* *

| | Man | | | | | | |
|---|---|---|---|---|---|---|---|
| | Post Mortem | Enucleated Eyes | Horse | Ox | Pig | Rabbit | Cat |
| Glucose, mg/100 ml. | 62 | 68[8]<br>70[16] | 57[10]<br>71[8] | 39[6] | 30[6] | 80[10] 92[8]<br>87[8] 104[16] | 45[8]<br>64[5] |
| Urea, mg/100 ml. | 79 | — | 47[16]<br>17-43[5] | 21[5] | 19[6] | — | — |
| Creatinine, mg/100 ml. | 1.2 | — | 1[19] | 1.1[6] | — | — | — |
| Chlorine, mEq/L. | 114 | — | 117[6]<br>112[5] | 120[21]<br>116[5] | 121[6] | — | — |
| Phosphorus, mEq/L. | 1.2 | — | 1.4[16] | 1.1[16] | — | 1.0[16] | — |
| Sodium, mEq/L. | 144 | — | 153[21]<br>135[5] | 144[21]<br>131[5] | 139[6] | — | — |
| Potassium, mEq/L. | 7.7 | — | 5.0[21]<br>6.3[5] | 4.9[21]<br>6.4[5] | 9.1[6]<br>7.3[5] | — | — |
| Calcium, mEq/L. | 3.6 | — | 4.1[21]<br>4.3[5] | 3.5[21]<br>4.0[5] | 4.0[6] | — | — |

*, Minor adjustments of reported figures were made, such as conversion of mg/100 ml. to mEq/L., of urea nitrogen to urea, and rounding second decimals to nearest first decimals, for the sake of better comparison.

TABLE 3.—*Ratios of* $\frac{\text{Vitreous Body}}{\text{Cerebrospinal Fluid}}$ *Values in Man and Animals* *

| | Values in Man | | | Values in Animals | | | | |
|---|---|---|---|---|---|---|---|---|
| | Post Mortem | | Ante Mortem | | | | | |
| | $\frac{\text{Av. VB}}{\text{Av. CSF}}$ | Av. of Individual Ratios | $\frac{\text{Enucl. Eyes}}{\text{Av. CSF}}$ | Horse | Ox | Pig | Rabbit | Cat |
| **Substances Subject to Minor Postmortem Changes** | | | | | | | | |
| Creatinine, mg/100 ml. | $\frac{1.2}{2.4} = 0.5$ | 0.7 | — | — | $\frac{1.1}{1.4} = 0.8$ | — | — | — |
| Chlorine, mEq/L. | $\frac{114}{113} = 1.0$ | 1.0 | — | $\frac{115}{113} = 1.0$ | $\frac{120}{116} = 1.0$ | — | — | — |
| Sodium, mEq/L. | $\frac{144}{127} = 1.1$ | 1.0 | — | — | — | — | — | — |
| Calcium, mEq/L. | $\frac{3.6}{2.4} = 1.5$ | 1.6 | — | $\frac{4.2}{3.2} = 1.3$ | — | — | — | — |
| **Substances Subject to Major Postmortem Changes** | | | | | | | | |
| Glucose, mg/100 ml. | $\frac{62}{40} = 1.6$ | 1.4 | $\frac{69}{70} = 1.0$ | $\frac{64}{56} = 1.1$ | $\frac{39}{65} = 0.6$ | $\frac{30}{65} = 0.5$ | $\frac{91}{54} = 1.7$<br>$\frac{0.40}{0.64} = 0.8$[7] | $\frac{55}{58} = 1.0$ |
| Urea, mg/100 ml. | $\frac{79}{89} = 0.9$ | 1.0 | — | $\frac{39}{27} = 1.4$ | $\frac{21}{11} = 1.9$ | — | — | $\frac{0.87}{0.64}$[6] $= 1.4$ |
| Phosphorus, mg/100 ml. | $\frac{1.2}{5.2} = 0.2$ | 0.3 | — | $\frac{1.4}{1.4} = 1.0$ | — | — | — | — |
| Potassium, mEq/L. | $\frac{7.7}{21} = 0.4$ | 0.5 | — | $\frac{5.0}{3.3} = 1.5$ | $\frac{4.9}{3.1} = 1.6$ | — | — | — |

* Compiled from values in Tables 1 and 2 and CSF values from literature.[11]

Table 2 presents a comparison of values of human VB with values in VB of animals as reported in the literature. It will be noted that with the exception of the postmortem urea value most postmortem values approached fairly closely some of the values reported in animals. For instance, postmortem values of creatinine, phosphorus, sodium, and calcium were close to the respective values in the ox, and postmortem values of glucose and chlorine fell into ranges reported for the VB of the horse. The values of potassium in the VB of the pig, a range with which the postmortem value would roughly agree, appeared too high, probably owing to technical difficulties of the older methods.

Another approach in evaluating postmortem chemistry in VB was the comparison of postmortem ratios of VB/CSF values with corresponding ratios in animals as compiled in Table 3. Such ratios could be expected to give a better comparison of values in different species, provided postmortem changes were causing the same or similar changes in VB and CSF with ratios approaching *intra vitam* values. For greater accuracy these ratios should be based on analyses of specimens of VB and CSF removed from the same body or animal at the same time under the same conditions and examined by identical methods. The postmortem ratios in Column 1 of Table 3 were based on average values of Table 1, while the ratios in Column 2 represented averages of individual ratios from results obtained in the same bodies. As seen, values in Column 1 and 2 were close or identical, indicating that both methods could be used here, provided averages were representative and accuracy required was not more than one decimal figure.

In this connection, an instance of gross discrepancy may be pointed out by the use of VB glucose values of rabbits in Table 2 resulting in a glucose VB/CSF ratio of 1.7. Based on Davson's ratios [7] of VB glucose/plasma glucose=0.49 and CSF glucose/plasma glucose=0.64, a VB/CSF ratio of 0.8 was computed, which fell into range between the ratio of 0.5 for the pig and 1.1 for the horse. Substituting in VB glucose/plasma glucose=0.49 the rabbit plasma glucose average of 85 mg/100 ml.,[28] the resulting value for VB glucose in the rabbit would be 42 mg/100 ml. instead of 80-104 mg/100 ml. as listed in Table 2.

Substances previously found to be subject to minor postmortem changes (Table 3) showed fair agreement of postmortem VB/CSF ratios in man with ratios in animals. The VB creatinine in man and ox was smaller than CSF creatinine, and the ratio of 0.7 in man was close to 0.8 in the ox. The chlorine ratios in man, horse, and ox were all 1.0, indicating that this anion was evenly distributed in VB and CSF. The calcium ratios in man and horse were both greater than 1.0, owing to higher concentration in VB than in CSF.

Substances subject to major postmortem changes, glucose, urea, phosphorus, and potassium, showed these changes mainly in CSF, resulting in distortion of ratios. Thus a glycolytic decrease of CSF glucose tended to increase the VB/CSF ratio, while increase of CSF phosphorus and potassium caused a decreased ratio. This effect was less conspicuous in the case of urea, which showed a similar marked rise in VB as in CSF. All these ratios were at variance with those in animals based on values obtained during life or shortly after sudden death. On the other hand, the glucose ratio in man based on values in enucleated eyes and average values in CFS was 1.0 instead of 1.6 and 1.4 and closely matched the ratios in cat and horse.

An attempt was made to base estimates of *intra vitam* values in human VB on the data in Tables 1 and 3 under the following assumptions:

(*a*) that the rate of postmortem changes of some substances would be the same or similar in VB as in CSF and that, therefore, the postmortem value in VB multiplied with the ratio antemortem CSF/postmortem CSF would approach *intra vitam* values in VB;

TABLE 4.—*Estimates of Normal Average Values in Vitreous Body of Man During Life, Based on Postmortem Chemistry of the Vitreous Body, Antemortem Chemistry of Cerebrospinal Fluid, and Values Reported in Animals*

| | Postmortem VB Values | Antemortem CSF Values | Antemortem VB = Postmortem VB × $\frac{\text{Antemortem CSF}}{\text{Postmortem CSF}}$ | Antemortem VB = Antemortem CSF × $\frac{\text{VB}}{\text{CSF}}$ (Animal) | Other Derivations | Most Likely Antemortem VB Values, Man |
|---|---|---|---|---|---|---|
| **Substances Subject to Minor Postmortem Changes** | | | | | | |
| Creatinine, mg/100 ml. | 1.2 | 1.1 | 1.2×0.5=0.6 | 1.1×0.8=0.9 | — | VB<CSF 0.8-0.9 |
| Chlorine, mEq/L. | 114 | 125 | 114×1.1=125 | 125×1.0=125 | — | VB=CSF 125 |
| Sodium, mEq/L. | 144 | 143 | 144×1.1=158 | — | Total cations** 150<br>Ca 3.6<br>K 3.0<br>Mg 2.0† −9<br>141 | VB=CSF 141 |
| Calcium, mEq/L. | 3.6 | 2.5 | 3.6×1.0=3.6 | 2.5×1.3=3.3 | — | VB>CSF 3.6 |
| **Substances Subject to Major Postmortem Changes** | | | | | | |
| Glucose, mg/100 ml. | 62 | 65 | 62×1.6=99 | 65×0.8*=52 | 69<br>Enucl. eyes | VB<CSF 52-69 |
| Urea, mg/100 ml. | 79 | 14 | 79×0.2=16 | 14×1.4=20 | — | VB>CSF 16-20 |
| Phosphorus, mEq/L. | 1.2 | 0.8 | 1.2×0.2=0.2 | 0.8×1.0=0.8 | — | VB=CSF 0.8 |
| Potassium, mEq/L. | 7.7 | 2.9 | 7.7×0.1=0.8 | 2.9×1.5=4.4 | serum (man)×$\frac{\text{VB}}{\text{serum}}$ (horse)**<br>$4.2\times\frac{5.0}{6.3}=3.3$ | VB>CSF 3.3 |

* Average value of five species listed in Table 3.

† Mg. value in VB assumed to equal that in CSF.

(*b*) that the ratio of VB/CSF values of some substances in man would be the same or similar as in some animals and, therefore, the antemortem VB in man would equal that of the antemortem CSF value in man multiplied by the ratio VB/CSF in some animals;

(*c*) that the acid-base equilibrium of postmortem VB, antemortem VB, and antemortem CSF would be equal or similar, that cation milliequivalents in postmortem VB would total 150, and that thus sodium in antemortem VB would equal 150 minus the sum of calcium, potassium, and magnesium.

As seen in Table 4, estimates of *intra vitam* values based on Assumptions (*a*) and (*b*) were very close for substances subject to minor postmortem changes, creatinine, chlorine, and calcium. Of substances subject to major postmortem changes only urea gave fair agreement, while estimates of glucose, phosphorus, and potassium based on Assumption (*a*) were obviously too high or too low, respectively. Based on Assumption (*b*), glucose and phosphorus estimates were acceptable, while that of potassium was apparently too high. The most likely values in VB of man during life will be discussed below in greater detail.

## Comment

Data on postmortem chemistry of VB in man can become meaningful only by comparison with data on body fluids of related physiologic function, such as CSF, or with data on the VB in mammals, in which anatomy and physiology of the eye resemble that of man. An evaluation of these data (Tables 1-3) appeared possible by assessing the nature and extent of postmortem changes on each of the substances under investigation. From former studies on postmortem chemistry in CSF and blood,[19-23] it had been known that there were major postmortem changes of some substances, for instance, the decrease of glucose due to postmortem glycolysis, the increase of glucose due to postmortem glycogenolysis in vessels draining the liver, the marked not fully explained rise of urea, the sharp increase of potassium due to autolytic permeability changes of cell membranes, and the increase of phosphorus due to postmortem esterase activity. Other substances undergo minor changes, such as chlorine and sodium, both of which are slightly lowered in CSF, while creatinine shows a slight increase and calcium apparently remains unchanged after death.

Under otherwise equal conditions postmortem changes in body fluids would be the more marked the more contact there would be with cells or cellular tissues, and thus serum showed more postmortem changes than CSF and CSF was found to show more changes than VB, an acellular globular mass contacting the cellular retina peripherally only. An illustration of these varying conditions was the marked difference of average glucose values in mixed specimens of VB, 62 mg/100 ml., and of CSF, 40 mg/100 ml. Since glucose in VB of enucleated, traumatized eyes had been reported by Ask[3] and Magitot and Lenoir[16] as 68 and 70 mg/100 ml. and since glucose during life was not likely to approach the serum level of 97 mg/199 ml.[28] but would rather be lower than in CSF as observed in several animals, it was concluded that normal VB glucose levels *intra vitam* would be not much higher than 62 mg/100 ml. and that, therefore, postmortem glycolysis in VB was only slight. In the case of potassium, which rose to 7.7 mEq. per liter in VB and 21 Eq. per liter in CSF after death, values in VB during life would hardly be smaller than antemortem CSF potassium of 2.9 mEq. per liter but rather greater. The postmortem rise of potassium in VB was thus about twice the assumed antemortem value compared to a seven times increase in CSF. A similar relationship was found regarding phosphorus values, whose postmorten rise could also be assumed to be considerably less in VB than in CSF.

Conditions would have to be different in the case of urea, which in VB showed almost the same marked rise, 79 mg/100 ml., as in CSF, 89 mg/100 ml. This change had been found in blood, CSF, VB, and other body fluids almost to the same extent and presumably would be caused by a mechanism affecting the body as a whole. Since the rise of urea has not been observed in sudden death, a likely mechanism appeared to be circulatory changes during the agonal phase preceding death. On the other hand, substances known to undergo minor postmortem changes in CSF could be assumed to show similar or lesser changes in VB. Calcium had been found unchanged in CSF and serum after death [23] and probably would be unchanged also in VB. Sodium and chlorine in CSF showed only moderate decrease and creatinine a moderate rise after death and would likely undergo similar slight changes in VB.

These assessments of postmortem changes were thought to provide means to obtain a more concrete idea of *intra vitam* values in human VB, and, since the VB of normal eyes in living man would hardly ever be subjected to chemical examination, it was intriguing to speculate on what the most likely average normal values in human VB would be during life. Estimates based on the above-formulated assumptions that postmortem changes of some substances in VB would be similar as in CSF and that the ratios of VB/CSF values of some substances in man would be similar as in some mammals (above and Table 4) were believed to narrow down the ranges of likely values during life.

The same reasoning leading to the conclusion that postmortem glycolysis in VB is insignificant was adduced in estimating a likely glucose range of 52-69 mg/100 ml., which would be near the postmortem value of 62 mg/100 ml., not higher than 69 mg/100 ml., the average of two values in enucleated eyes, and not lower than 52 mg/100 ml. computed on the Assumption (*b*) above. There was apparently a parallel postmortem rise of urea in VB and CSF, since estimates based on Assumptions (*a*) and (*b*) above yielded values of 16 and 20 mg/100 ml., a range generally considered below the upper limit of normality in other body fluids and slightly higher than the average normal value in CSF similar as in the horse and ox. The antemortem VB creatinine estimates of 0.8 and 0.9 mg/100 ml. on the basis of Assumptions (*a*) and (*b*) were close and both below the antemortem CSF average of 1.1 mg/100 ml.

Of electrolytes chlorine showed remarkable agreement of figures, 125 mEq. per liter estimated on the basis of Assumptions (*a*) and (*b*), suggesting the same concentration of this anion in VB and CSF during life. The corresponding values for calcium, 3.6 and 3.3 mEq. per liter were fairly close and both higher than in antemortem CFS, probably due partly to a larger protein-bound fraction in VB. Since calcium was known to be stable after death, as pointed out before, 3.6 mEq. per liter could be accepted as the most likely antemortem VB estimate.

Both potassium estimates of 0.8 and 4.4 mEq. per liter were obviously improbable. Assumption (*a*) that postmortem changes in VB would be the same or similar as in CSF could not be expected to apply in the case of potassium, which would rise at a greater rate in CSF after death owing to permeability of a larger membrane surface, thus resulting in too small an estimate. Assumption (*b*), on the other hand, yielded too high an estimate, which exceeded the serum potassium of 4.2 mEq. per liter,[28] probably owing to analytical errors of determinations in animal fluids by the older potassium methods. A more reasonable and likely estimate was based on the ratio of VB/plasma values in the horse according to Tron [31] (Table 4, Column 5) resulting in 3.3 mEq. per liter of potassium in human antemortem VB. Similarly the phosphorus estimate of 0.2 mEq. per liter based on Assumption (*a*) was apparently too small, due to the more marked rise of phosphorus in CSF. Assumption (*b*) yielded 0.8 mEq. per liter of phosphorus, which equaled that

in antemortem CSF and appeared the best estimate available.

The sodium estimate was based on Assumption (*c*) above and would result from the estimated total cations of 150 mEq. per liter minus 9 mEq. per liter representing the sum of calcium, potassium, and magnesium.[23] For the sake of this estimate a magnesium value of 2 mEq. per liter was assumed to equal that of antemortem CSF. The calculated sodium of 141 mEq. per liter in antemortem VB was close to 143 mEq. per liter, average sodium value in antemortem CSF, and also to 144 mEq. per liter, average sodium value in postmortem VB. This indicated that there was no significant change of sodium concentration after death.

Finally, it may be pointed out that the above estimates given for normal average values in VB of man during life can be no more than rough approximations and attempts to convey an idea of what may be possible and probable in the absence of more direct and accurate measurements.

## Summary

Specimens of vitreous body VB removed at autopsy from 211 bodies have been analyzed for glucose, urea, creatinine, chlorine, phosphorus, sodium, potassium, and calcium and results compared to postmortem and antemortem values in cerebrospinal fluid (CSF) and to values in VB and CSF of animals from the literature; ratios of postmortem VB/CSF values in man have been compared to those of values in animals.

Postmortem changes in human VB about nine hours after death were considerably less marked than in CSF and consisted mainly of the postmortem rise of urea and small increases of potassium and phosphorus, while postmortem glycolysis was slight.

Average values in postmortem VB, probably close to *intra vitam* values, were 62 mg/100 ml. of glucose, 1.2 mg/100 ml. of creatinine, 114 mEq. per liter of chlorine, 144 mEq. per liter of sodium, and 3.6 mEq. per liter of calcium, while moderate increases were 7.7 mEq. per liter of potassium and 1.2 mEq. per liter of phosphorus and a marked rise was 79 mg/100 ml. of urea.

Estimates of normal average values in VB of man during life have been attempted based on the assumptions that some substances would undergo similar postmortem changes in VB as in CSF, that the ratio VB/CSF of some substances would be similar in man as in some animals and that the acid-base equilibrium would be the same in VB as in CSF.

J. M. Young, M.D., Chief, Laboratory Service, supplied material from autopsies; A. C. Krause, M.D., Chief, Ophthalmology Section, valuable advice, and Abbie M. Olsen, A. B., M. T. (ASCP), Chief Technician, and the laboratory staff, technical assistance.

Park Ave. and Getwell St. (15).

## REFERENCES

1. Adler, F. H.: An Investigation of the Sugar Content of the Ocular Fluids Under Normal and Abnormal Conditions, and the Glycolytic Activity of the Tissues of the Eye, Tr. Am. Ophth. Soc. 28:307-340, 1930.

2. Adler, F. H.: Is the Aqueous Humor a Dialysate? Arch. Ophth. 10:11-19, 1933.

3. Ask, F.: Zur Kenntnis des Traubensuckergehaltes des Glaskoerpers, Acta Ophth. 5:23-28, 1927.

4. Cockrill, J. R.: Nonelectrolytes: Their Distribution Between the Blood and Cerebrospinal Fluid, Arch. Neurol. & Psychiat. 25:1297-1305, 1931.

5. Cohen, M.; Killian, J. A., and Metzgar, N.: Studies in the Chemistry of the Humors of Animal Eyes and a Comparison of Their Composition with That of Blood and Cerebrospinal Fluid: Contributions to Ophthalmic Science Dedicated to Dr. Edward Jackson, Menasha, Wis., George Banta Publishing Co., 1926, pp. 216-228.

6. Cohen, M.; Killian, J. A., and Metzgar, N.: Chemical Composition of the Vitreous Humor of Animal Eyes, Proc. Soc. Exper. Biol. & Med. 22:445-446, 1922.

7. Davson, H.: Physiology of the Ocular and Cerebrospinal Fluids, Boston, Little, Brown & Company, 1956, pp. 99, 250, 271, 285, 286.

8. Duke-Elder, W. S.: Textbook of Ophthalmology, Vol. 1, St. Louis, The C. V. Mosby Company, 1946, p. 428.

9. Duke-Elder, W. S., and Davson, H.: Studies on Intraocular Fluids; Reducing Substances in Aqueous Humor and Vitreous Body, Brit. J. Ophth. 33:21-38, 1949.

10. Duke-Elder, W. S., and Goldsmith, A. J. B.: Recent Advances in Ophthalmology, Ed. 4, St. Louis, The C. V. Mosby Company, 1951, p. 8.

11. Fischer, F. P.: Der Mineralbestand des Auges, Arch. Augenh. 107:295-318, 1933.

12. Hata, M.: Der Gehalt des Glaskörpers des Kaninchens an Zucker und Milchsäure und der Einfluss der Pharmaka auf dasselbe, Mitt. Med. Akad. Kioto 31:375-376, 1941.

13. Hawk, P. B.; Oser, B. L., and Summerson, W. H.: Practical Physiological Chemistry, Ed. 13, The Blakiston Company (division of McGraw-Hill Book Company, Inc.), 1954, pp. 555, 568, 627, 630, 644.

14. James, W. M., and Siefker, A. J.: Observations on the Reducing Substances (Glucose) of the Aqueous and Vitreous Humors of the Eye, Am. J. Ophth. 19:975-981, 1936.

15. Krause, A. C.: The Biochemistry of the Eye, Baltimore, The Johns Hopkins Press, 1934, pp. 164, 165.

16. Magitot, A., and Lenoir, A.: La Teneur en glucose du corps vitré de l'oeil humain, Comp. rend. Soc. biol. 110:1251-1252, 1932.

17. Natelson, S.: The Routine Use of the Perkin-Elmer Flame Photometer in the Clinical Laboratory, Am. J. Clin. Path. 20:463-472, 1950.

18. Naumann, H. N.: A Simplified Urea Determination for Routine Blood Chemistry, J. Lab. & Clin. Med. 26:405-408, 1940.

19. Naumann, H. N.: Urobilinogen in Cerebrospinal Fluid, Proc. Soc. Exper. Biol. & Med. 65:72-74, 1947.

20. Naumann, H. N.: Diabetes and Uremia Diagnosed at Autopsy by Testing Cerebrospinal Fluid and Urine, Arch. Path. 47:70-77, 1949.

21. Naumann, H. N.: Studies on Postmortem Chemistry, Am. J. Clin. Path. 20:314-324, 1950.

22. Naumann, H. N.: Postmortem Glucose, Letter to the Editor, J. A. M. A. 157:780, 1955.

23. Naumann, H. N.: Cerebrospinal Fluid Electrolytes After Death, Proc. Soc. Exper. Biol. & Med. 98:16-18, 1958.

24. Palm, E.: The Phosphate Content of the Vitreous Body, Acta ophth. 27:553-562, 1940.

25. Pirie, A., and Van Heyningen, R.: The Biochemistry of the Eye, Oxford, Blackwell Scientific Publications, 1956, p. 36.

26. Santoni, A.: Ricerche sull' indice di refrazione e sul contenuto in glucosio del vitreo nel corso della degenerazione corioretinica sperimentale da iodato di sodio, Ann. ottal. clin. ocul. 74:590-598, 1948.

27. Salit, P. W.: Calcium Content of the Aqueous and Vitreous Humors and Serum, J. Biol. Chem. 104:275-280, 1934.

28. Spector, W. S.: Handbook of Biological Data, Philadelphia, The W. B. Saunders Company, 1956, pp. 53, 57, 76.

29. Stary, Z., and Winternitz, R.: Zur Chemie des Glaskörpers, Arch. Augenh. 108:433-442, 1934.

30. Sunderman, F. W.; Leffler, H. H.; MacFate, R. P.; Martens, V. E.; Naumann, H. N.; Stevenson, G. F.; Sunderman, F. W., Jr., and Teloh, H. A.: Manual of American Society of Clinical Pathologists Workshop on Serum Cations, Am. J. Clin. Path. 30:269-283, 1958.

31. Tron, E.: Chemische Untersuchungen über die Natur der intraokulaeren Flüssigkeiten, von Graefes Arch. Ophth. 117:677-692, 1926; 118:713-722, 1927.

32. Weisberg, H. F.: Water and Electrolyte Balance, Bull. Mount Sinai Hospital, Chicago, 2:65-80; 85-126; 154-180, 1950.

# Ataxia-Telangiectasia

J. LAWTON SMITH, M.D., and DAVID G. COGAN, M.D., Boston

Ataxia-telangiectasia is a familial disorder characterized primarily by a progressive cerebellar ataxia with onset in infancy, associated with conjunctival telangiectasia and unusual ocular movements. An isolated case was first reported in 1941, by Louis-Bar,[1] but the syndrome has been defined only in the past two years. The reports of Boder and Sedgwick,[2] Centerwall and Miller,[3] and Wells and Shy,[4] all since 1957, have established it as a clinical entity, and to date a total of 20 cases in 12 families, involving 12 females, 8 males, and 7 pairs of siblings are known. Among the known cases are four which have not been reported individually, and it is one of these called to our attention by Dr. Frank Ford that led to our awareness of the syndrome. As ataxia-telangiectasia has striking ocular manifestations and has not heretofore been reported in the ophthalmologic literature, the following case is presented. This is the 21st known case and the 1st in the Negro race.

The main features of the syndrome are as follows: (1) progressive cerebellar ataxia with onset in infancy; (2) symmetrical telangiectasia of the bulbar conjunctivae, usually somewhat later in onset; (3) occasional cutaneous telangiectasia of the face, ears, and other sites; (4) peculiarity of eye movements involving primarily voluntary gaze; (5) susceptibility to frequent sinus and pulmonary infections, and (6) familial incidence. Other features noted have included deep tendon areflexia with flexor plantar responses, intact cranial nerve function, scanning speech, drooling, retardation of skeletal development, intact sensation, hair and skin changes, equable disposition, and pneumoencephalographic evidence of cerebellar atrophy. The presence of associated mental retardation has caused some difference of opinion. The ocular features of ataxia-telangiectasia are (1) normal vision; (2) normal pupils; (3) normal fundi; (4) poor convergence; (5) nystagmus, more marked in eccentric fixation than in the primary position; (6) poorly sustained conjugate gaze, resembling at times a partial ophthalmoplegia, and (7) conjunctival telangiectasia. Our case also showed (8) essentially absent optokinetic responses and (9) involuntary and maintained deviation of the eyes during rotation of the body.

Submitted for publication Jan. 7, 1959.

From the Howe Laboratory of Ophthalmology, Harvard University Medical School, and Massachusetts Eye and Ear Infirmary.

This work supported in part by special traineeship BT 357, National Institute of Neurological Diseases and Blindness, National Institutes of Health, U. S. Public Health Service.

## Report of Case

This 18-year-old Negro girl was first admitted to the Massachusetts General Hospital in 1953, because of a tremor of five years' duration. The patient was born July 13, 1939, the product of a pregnancy which had been uneventful until term, when the mother had a convulsion and was blind for three days. The patient's development, however, proceeded normally, as the child walked at 11 months and said some words plainly by 18 months. At age 4 years, the child fell and thereafter had difficulty walking. At 8, the patient entered the first grade, but after recovery from measles an intention tremor of the hands was noted which became so severe that the child had to stop school after two months. During the next five years, unsteadiness of gait progressed so that the patient could not stand without support. At age 12 the patient had pneumonia. She began to drool, and her speech

became difficult to understand. Because of increasing ataxia and apparent mental retardation, she was hospitalized. There was no history of headache, convulsions, sinusitis, or visual symptoms.

The family history revealed that two siblings were in good health but that a 26-year-old brother had seizures. The father was dead, and there was little information concerning him or his family. There was no history of a similar illness on the maternal side of the family.

Physical examination revealed a thin Negro girl, unable to stand, who, although cooperative and oriented, appeared inattentive and mentally retarded. Except for innervation of the eyes, the cranial nerves were within normal limits. Examination of the motor system revealed poor coordination, but strength seemed adequate. The deep tendon reflexes were absent. Sensation was intact. The plantar responses were flexor. Cerebellar function was grossly abnormal. The most prominent findings were (1) mental retardation; (2) ataxia of movements affecting limbs and bulbar musculature, giving the speech a scanning and explosive character; (3) intention tremor on voluntary movement of the limbs; (4) peculiar twitches throughout the body, and (5) lack of pattern or rhythm and quickness of the jerks which continued while the limbs were at rest or in motion.

Examination of the eyes revealed that the patient had full versions but could not maintain gaze in any direction. Vertical nystagmus was noted on elevation, and horizontal nystagmus on gaze to either side. The pupils were normal, and convergence was poor. The patient was seen by one of us (D. G. C.) on April 10, 1953, and the following notes were made: "eye movements are interesting. Noteworthy is the inability to look voluntarily to either side readily on command with consequent overshooting of head. When patient does get her eyes to one side they drift back to the primary position. This is more evident on gaze to the right than to the left. Vertical gaze similarly affected but downward gaze much more than upward (which appears to be the best maintained of any movement). Intermittent vertical nystagmus in the primary position with fast component downward. No optokinetic response to either side. No Kayser Fleischer ring." It was also noted that the patient had a Roth-Bielschowsky type of deviation on rotation of the head. Thus on head turning to either side, the eyes showed an involuntary contraversive movement with a slow return to the primary position. This sign together with the defect in voluntary movement was similar to what had previously been described in the syndrome of congenital ocular motor apraxia.[5]

Cortical function tests revealed an intelligence quotient of 45 (mental age, 6 years, 1 month; chronologic age, 13 years, 9 months). Laboratory studies revealed a negative urinalysis; hemoglobin 12.9 gm. %; white blood cell count 7,100, with 40% polymorphonuclear cells, 44% lymphocytes, 9% monocytes, and 7% eosinophils.* The spinal fluid was clear, acellular, and under normal pressure, with a total protein of 76 mg. %. Sulfobromophthalein (Bromosulphalein) was 4% retention in 45 minutes, and cephalin flocculation was 2+ in 48 hours. The Hinton test was negative on blood and spinal fluid. Serum iron 120μg. %. Twenty-four-hour urine for amino acids was 98 mg. per liter as α-amino nitrogen. Skull x-rays revealed a small calvarium, and the sagittal and coronal sutures appeared to be fused. The bones were normal, and the sella was normal in size and shape. A craniostenosis was considered by the radiologist.

Because of the mental retardation, ataxia, intention tremor, and peculiar twitches, which were thought by some to be myoclonic, a clinical impression at that time was dyssynergia cerebellaris myoclonica of Ramsey Hunt.[6] The patient was discharged unchanged.

During the past five years, the patient's activities have been very limited, and she has led a bed and wheel-chair existence.

* Centerwall and Miller.[5] One of their cases had "occasionally an inadequately explained eosinophilia (eosinophils ranging from 7% to 15%)."

Figure 1

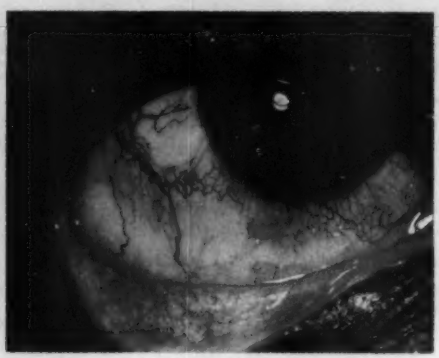


Figure 2

Because of gradual progression of the illness, she was readmitted Dec. 16, 1958, for evaluation.

Positive findings on examination included mental retardation with poor insight. The patient was oriented as to place but not to time. There was slurring, explosive speech, inability to walk, and a lurching gait when supported. Marked cerebellar ataxia with violent intention tremor was present. Jerks and twitches of the entire body were seen at times with no pattern or rhythmicity, which were not considered to be typical of myoclonus. Sensation was intact and motor strength symmetrical, but there was generalized areflexia with slight hypotony.

Ophthalmologic examination revealed the vision to be at least 20/100 in both eyes with use of the children's test set,[7] but the mental status did not permit further evaluation of acuity. Two abnormalities of interest were noted—conjunctival lesions and unusual ocular motility. A striking finding was the presence of myriads of large, tortuous dilated conjunctival vessels noted for the most part on the bulbar conjunctiva nasal and temporal to the limbus in both eyes. The lower fornix and plica semilunaris was involved bilaterally as well. To a smaller degree the episcleral vessels and even the lower palpebral conjunctivae were affected. The conjunctiva was normal between these large vessels, and, interestingly, the upper bulbar conjunctiva was spared in both eyes. The vessels presented aneurysmal dilatations in some areas and extended from the canthi to connect with the limbal plexuses. The corneae were normal. The greatest tortuosity and corkscrewing were noted in the veins serving as intervenular bridges rather than in the main venous trunks accompanying the arteries.

The ocular motor abnormality showed the same features noted five years previously. This was characterized by (1) an inability to execute voluntary gaze movements rapidly and smoothly on command, despite full excursions on casual gaze or with effort; (2) maintained contraversive deviation of the eyes during rotation of the body; (3) reluctance to maintain eccentric gaze, and (4) occasional vertical nystagmus. The versions were performed in a dyssynergic halting fashion, and both vertical and horizontal movements were affected. No true ocular or palatal myoclonus[8] was seen. There were no ocular bruits, and the optokinetic responses were essentially absent. Ophthalmoscopy revealed normal fundi. There were no other telangiectasia seen on the ears, face, buccal mucosa, or nail beds.

A repeat electroencephalogram was normal. Lumbar puncture revealed a normal pressure, 2 lymphocytes per cubic millimeter, and protein 92 mg. %. A pneumoencephalogram revealed no evidence of cortical atrophy and a normal ventricular system, but there was definite evidence of cerebellar atrophy. A repeat cortical function test indicated that no significant loss in

mental ability had occurred in the five-year interval since the first admission but that the patient remained in the "defective" range with an I. Q. of 37.

Further history from the patient's mother revealed that the patient had been noted to have "red eyes" for over two years. A review of moving pictures made of the patient in 1953 showed slight if any abnormal vessels of the eyes at that time. The clinical impression was ataxia-telangiectasia.

## Comment

Boder and Sedgwick summarized the findings in their eight cases of ataxia-telangiectasia as follows:

| Neurologic features | % Incidence |
|---|---|
| Cerebellar ataxia with onset in infancy | 100 |
| Decreased deep reflexes | 85 |
| Flexor plantars | 100 |
| Negative Romberg sign | 100 |
| Intact sensation | 100 |
| Ocular motor signs | |
| Peculiarity of eye movements | 100 |
| Fixation nystagmus | 87 |
| Oculocutaneous telangiectasia | 100 |
| Dysarthric speech | 100 |
| Familial incidence | 85 |
| Frequent sinopulmonary infection | 75 |
| Drooling | 87 |
| Associated features | |
| Equable disposition | 100 |
| Retardation of statural development | 75 |
| Changes of hair & skin | 100 |

It is seen that our case presents each of the features listed above with but two exceptions—absence of family history and absence of frequent sinus infections. Although one brother has had seizures, there is no definite family history in our case of a similar illness. A negative family history was also present in 4 of the 11 reported cases in which relevant data are given. With regard to pulmonary involvement in this syndrome, Boder and Sedgwick [2] stated, "although bronchiectasis may be severe enough to overshadow the neurologic picture and may be the cause of death, it is clearly not an essential component of the syndrome." Likewise, one of their cases had no significant involvement of the respiratory tract.

This case raises several new features of the disease. This is the first instance reported in the Negro race. Some elevation of the cerebrospinal fluid protein was evident in our case (76 mg. % at age 13 and 92 mg. % at age 18). This has not been noted heretofore, but such a finding may occur in cerebellar degenerations, and it should be pointed out that our case is rather far advanced. Our patient presented pneumoencephalographic evidence of cerebellar atrophy. This has been a common finding in other cases but has not been sufficiently emphasized.

The strictly ophthalmologic features of this syndrome are of great interest. The large tortuous conjunctival vessels may be seen in the figures. These have frequently led to a mistaken diagnosis of "conjunctivitis." In the patient here reported, the vessels were symmetrical in the two eyes, arose in the canthal regions, appeared primarily venular in nature, and did not appear to arise from muscle insertions. The plica semilunaris and lower tarsal conjunctiva were involved to a lesser degree in both eyes. The upper bulbar conjunctivae and corneae were not involved. The conjunctival lesions do not resemble morphologically those of Rendu-Osler-Weber disease,[9] nor does the latter produce such a syndrome of progressive cerebellar ataxia. A careful search of the fundi by indirect ophthalmoscopy for evidence of Von Hippel-Lindau's disease was negative, nor have any fundus lesions been described in other cases of ataxia-telangiectasia.

The disturbance of ocular motility appears to be very similar in these patients. The appearance of a "partial ophthalmoplegia" previously described was seen typically in our case and was likened to congenital ocular motor apraxia of horizontal movements. The versions were performed in a halting, dyssynergic fashion, and, although with effort they were carried through a full excursion, the latter was poorly sustained. On rotation of the head there was involuntary contraversive deviation of the eyes, such as is characteristic

of the Roth-Bielschowsky sign. Vertical nystagmus was noted at times in this case. No true ocular myoclonus was evident. As the vision is characteristically normal in ataxia-telangiectasia, a failure to obtain a better acuity than 20/100 in this case have been due to the mental retardation, although vision was reduced somewhat in one of Centerwall's cases. A markedly diminished to absent optokinetic response was noted in this case even though very large targets were used.

There has been some controversy about the mental status in ataxia-telangiectasia. Centerwall and Miller commented, "of particular interest in these cases is the problem of whether or not the children are mentally retarded." They noted that "insufficient scholastic attainment" was described in Louis-Bar's original case, but the authors attributed this "mainly to neuromuscular disability." On the other hand, Boder and Sedgwick, in a larger series, pointed out that all of their cases below age 9 had normal intelligence, whereas a lowered I. Q. was evident in those above 9. They attributed this to an arrest at mental age 5-10 years, with the disparity of chronologic age primarily responsible for a subsequent lowering of the intelligence quotient. Our case is of interest in this regard, and it may be of value to quote the comments of the psychologists who studied her at age 13 and later at age 18: "4-7-53. Cortical function tests administered to this 13 year, 9 month old young girl indicate mental ability to be 'defective' in range. Her intelligence quotient is 45. Mental age was established at year 6, one month. It may be mentioned that the child's vocabulary level (usually a good indication of general ability) substantiates the diagnosis of 'mental defectiveness.' A majority of the patient's ability is centered around the sixth year. However, at age 7 she passes a counting test. At year 8 she is able to say the days of the week and deal effectively with a comprehension test. The patient's speech is characterized by a severe articulatory disturbance plus an inadequate supply of breath upon expiration. Many times she will barely evoke the second syllable of a word. She seems to be a happy child (not being fully cognizant of her limitations) for she smiles frequently and is most agreeable. It is not felt that the patient's incapacitation significantly affected the examination." Five years later: "12-19-58. Retesting of this 19 5/12 year old girl shows no significant loss in mental ability. She remains in the 'defective' range, with an obtained intelligence quotient of 37. Her present mental age is five years and seven months. The range of tests covered in the administration of the Stanford-Binet was approximately that of the first testing. She passed all tests at the 3 year 6 months level and failed all at year 8. At the seven year level the subject was able to give the number of fingers on each hand and to repeat a sentence from memory. Her score on the children's Raven's, primarily nonverbal in nature but requiring no motor response from the patient, was consistent with the intelligence quotient established. The severe articulatory difficulty . . . remains, but with coaxing on the part of the examiner it did not seriously affect the recording of responses." Our case therefore tends to support Boder and Sedgwick's interpretation of the mental status in ataxia-telangiectasia.

The electroencephalogram was repeatedly normal in our case. Boder and Sedgwick reported electroencephalographic findings in six of their eight patients, and all were within normal limits.

## Summary

A case of ataxia-telangiectasia is reported. Although this entity has prominent eye signs, this is the first case to have been reported in the ophthalmologic literature. The syndrome consists primarily of progressive cerebellar ataxia, peculiarity of ocular movements, and conjunctival telangiectasia beginning in childhood. The ocular abnormalities are (1) a curious defect in executing voluntary ocular movements and inability to maintain full excursions of the

eyes and (2) the presence of prominent conjunctival vessels, which have been so marked as to be called telangiectasia. The vision, pupils, and fundi are usually normal, as is the electroencephalogram.

The case here reported showed, in addition to the typical features, the following aspects not previously noted: 1. It was the first case in the Negro race and the second oldest in chronologic age. 2. The spinal fluid protein was elevated. 3. Vertical nystagmus was present, and the optokinetic nystagmus response was absent. The pneumoencephalographic evidence of cerebellar atrophy noted in this case has also been reported in other cases and appears to deserve further emphasis.

The ophthalmological signs of ataxia-telangiectasia are of prime importance in its recognition.

The patient here reported was seen with the permission of Dr. David Poskanzer.

243 Charles St. (14).

## REFERENCES

1. Louis-Bar: Sur un Syndrome progressif comprenant des télangiectasies capillaires cutanées et conjonctivales symétriques, à disposition naevoïde et des troubles cérebelleux, Confinia neurol. 4:32, 1941.

2. Boder, E., and Sedgwick, R. P.: Ataxia-Telangiectasia: A Familial Syndrome of Progressive Cerebellar Ataxia, Oculocutaneous Telangiectasia and Frequent Pulmonary Infection, Pediatrics 21:526 (April) 1958.

3. Centerwall, W. R., and Miller, M. M.: Ataxia, Telangiectasia, and Sinopulmonary Infections: A Syndrome of Slowly Progressive Deterioration in Childhood, A. M. A. J. Dis. Child. 95:385 (April) 1958.

4. Wells, C. E., and Shy, G. M.: Progressive Familial Choreoathetosis with Cutaneous Telangiectasia, J. Neurol., Neurosurg. & Psychiat. 20:98, 1957.

5. Cogan, D. G.: A Type of Congenital Ocular Motor Apraxia Presenting Jerky Head Movements, Tr. Am. Acad. Ophth. 56:853 (Nov.-Dec.) 1952.

6. Hunt, R.: Dyssynergia Cerebellaris Myoclonica, Brain 44:490, 1921.

7. Allen, H. F.: Testing of Visual Acuity in Preschool Children: Norms, Variables and a New Picture Test, Pediatrics 19:1093 (June) 1957.

8. Cooper, J. C.: Eye Movements Associated with Myoclonus, Am. J. Ophth. 46:205 (Aug.) 1958.

9. Smith, J. L., and Lineback, M. L.: Hereditary Hemorrhagic Telangiectasia, Am. J. Med. 17:41 (July) 1954.

# Hypophysectomy as a Therapeutical Method for Proliferative Diabetic Retinopathy

S. VANNAS, M.D.; C. A. HERNBERG, M.D., and G. af BJÖRKESTEN, M.D., Helsinki, Finland

Proliferative diabetic retinopathy occurs as a dreaded complication of labile juvenile diabetes difficult to control with insulin. Prophylactically and therapeutically the blood sugar, fluid and electrolyte balance, and corticotropin (ACTH) and corticosteroid activity must be controlled.[19] Among the drugs employed are cyanocobalamin (vitamin $B_{12}$) and antifragility and lipotropic substances.[6,11,15,19] It is sometimes possible to delay the disease, especially in the incipient phase, for years even.

When the proliferative process has burst out, however, the cure or at least the prevention of its progress often fails, unfortunately. Recurrent hemorrhages lead sooner or later to incurable blindness—and to painful secondary glaucoma—if the patient lives long enough.

Numerous experimental observations and clinical investigations show that the development of diabetic retinopathy is associated with adrenal cortical hyperfunction which may even be the cause of the retinopathy.[5-7,9] Hypophysectomy reduces the adrenal function. On the other hand, it is possible that both diabetes and diabetic retinopathy are due primarily to the abnormal functioning of the hypophysis itself, in which case the adrenal cortical hyperfunction is a secondary phenomenon.[7,23] Recent experiments point to somatotropin of the pituitary as responsible for the diabetogenic action.[14,20] In either case, it may be hoped that hypophysectomy may have a beneficial effect on diabetic retinopathy. As the disease in question is like cancer in its poor prog-

Submitted for publication Dec. 31, 1958.

Presented at the meeting of the Finnish Ophthalmological Society, Helsinki, Nov. 29, 1958.

From the Ophthalmic Hospital of the Helsinki University, the Finnish Red Cross Hospital, and the Maria Hospital.

TABLE 1.—*Duration of Diabetes and Its*

| Case | Age | Sex | Duration of Diabetes, Yr. | Lability | | Observation Time of Eyes Before Operation, Mo. | Duration of Visual Impairment, Mo. | Vision | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Hypoglycemia | Acidosis | | | R. E. | L. E. |
| 1 | 26 | F | 13 | ++ | | 4 | 4 | H. M. | 0.8 |
| 2 | 16 | M | 10 | + | + | — | | 0.25 | 1.0 |
| 3 | 54 | F | 18 | + | + | 12 | 15 | H. M. | 0.2? |
| 4 | 22 | F | 14 | + | + | 72 | 3 | F. C. 0.5m | 1.3 |
| 5 | 36 | M | 15 | | ++ | 15 | 12 | 0.3 | $\frac{1}{\infty}$ |
| 6 | 23 | M | 16 | | +++ | — | 2 | 0.8 | 1.0 |
| 7 | 38 | M | 16 | | ++ | 4 | 4 | 0.15 | 0.4 |
| 8 | 17 | M | 16 | + | + | — | 5 | 0.25 | 1.0 |
| 9 | 35 | M | 16 | + | + | 6 | 18 | 1.0 | $\frac{1}{\infty}$ |
| 10 | 24 | F | 16 | ++ | + | 6 | 4 | $\frac{1}{\infty}$ | 0.6 |

* Hem. indicates hemorrhages; ex., exudates; prol., proliferations; vein, engorged venules, macroaneurysms, dilated capillaries.

nosis, a measure as radical as hypophysectomy is regarded as justified.

The first hypophysectomy on a diabetic was performed by Chabanier [8] in 1936. The second, by Olivecrona, in 1951, was performed on a patient already blind. The Swedes have in fact the largest material reported in this field, namely, 20 cases in 1952. The total of hypophysectomies reported from various countries is around 60: Luft, Olivecrona, Ikkos, Kornerup, Ljunggren, Nilsson, and Sjögren (1952), 20; Schimek (1956), 5; Gordon (1956), 11; Kinsell (1957), 9; Moore and others (1957), 1; Javid and others (1958), 10; Andersson and Kjerulf (1958), 2, and Nabarro and Slater (1958), 3 cases. Owing to the small number of cases operated on and the short observation period, the value of hypophysectomy as a clinical method for proliferative diabetic retinopathy has yet been fully assessed.

This is a report of ophthalmological observations made before and after hypophysectomy performed on the 10 patients of our material.

### Material and Its Selection

Our material comprised four women and six men aged 16-54 (Table 1). The diabetes of labile type had lasted from 10 to 18 years. One patient (Case 6), who was extremely difficult to control with insulin, often showed acidosis in spite of a daily dose of 160 units. Nine patients had diabetic retinopathy. In one patient (Case 2) severe nephropathy was the indication for surgery.

The material included cases under ophthalmological observation prior to the operation whose vision and fundal changes had deteriorated steadily despite careful control of labile diabetes and infections and despite other pertinent pharmacotherapy mentioned above. We generally endeavored to perform the operation in the phase when the proliferative changes of the better eye were still slight. All the patients concerned were informed that the operation with its attendant risks and drawbacks was an uncertain effort to save the vision still remaining.

There were also many cases who postponed the operation (Cases 3, 5, 9, and 10) or refused it. As an example may be mentioned a man of 24 who had suffered from labile diabetes for 13 years. He came for routine consultation from the medical clinic. Numerous fundal changes were found, in the left eye even proliferative ones. Vision R. E. was 0.67 and L. E. 0.2. Dental and

*Complications Before Hypophysectomy*

| Lens Opacities | | Retinopathy * | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | R. E. | | | | L. E. | | | | |
| R. E. | L. E. | Hem. | Ex. | Prol. | Vein | Hem. | Ex. | Prol. | Vein | Proteinuria |
| – | – | +++ | ++ | +++ | +++ | ++ | + | + | ++ | + |
| ++ | + | – | – | – | – | – | – | – | – | +++ |
| ++ | + | +++ | | (Invisible) | | ++ | +++ | ++ | ++ | + |
| – | – | +++ | ++ | +++ | +++ | ++ | – | – | + | + |
| – | – | ++ | ++ | ++ | ++ | +++ | ++ | +++ | +++ | + |
| – | – | + | + | + | + | + | + | – | + | + |
| – | – | +++ | +++ | ++ | +++ | +++ | ++ | – | +++ | |
| ++ | + | + | – | + | ++ | + | – | – | + | ++ |
| – | – | ++ | ++ | + | ++ | +++ | +++ | +++ | +++ | + |
| + | + | +++ | +++ | +++ | +++ | ++ | ++ | + | ++ | + |

newly formed vessels, capillary aneurysms.

TABLE 2.—*Postoperative Ocular Changes Compared with Those Before the Operation*

| Case | Age | Sex | Observation Time, Mo. | Eye | Vision | | Visual Field * | | Retinopathy | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Before | | | | After | | | | |
| | | | | | Before | After | Before | After | Hem. | Ex. | Prol. | Vein | Hem. | Ex. | Prol. | Vein | |
| 1 | 26 | F | 34 | R. E. | H. M. | 0 | Def. pr. | .. | +++ | ++ | +++ | +++ | Cataract after 1 yr. | | | | New attacks, evident infectious etiology |
| | | | | L. E. | 0.8 | 0.2 | N. | N. | ++ | ± | + | ++ | ± | ++ | ++ | + | |
| 2 | 16 | M | 3 | R. E. | 0.25 | 0.2 | N. | N.? | — | — | — | — | — | — | — | — | R. E.: diab. lens opacities; died 3½ mo. later |
| | | | | L. E. | 1.0 | 1.0 | N. | N.? | — | — | — | — | — | — | — | — | |
| 3 | 52 | F | 24 | R. E. | H. M. | 0 | Pr. | .. | +++ | invisible | | | —? | | As before | | Subcapsular lens opacities, less in the L. E. |
| | | | | L. E. | 0.2? | 1/∞ | Def. | Def. pr. | ++ | +++ | ++ | +++ | — | + | ++ | + | |
| 4 | 22 | F | 19 | R. E. | F. C. 0.5m. | 0 | Def. pr. | .. | +++ | ++ | +++ | +++ | — | — | +++ | ++ | Aphakia in both eyes |
| | | | | L. E. | 1.0 | 1.3 | N. | Def. | ++ | + | +? | + | — | — | — | — | |
| 5 | 36 | M | 14 | R. E. | 0.3 | 0.1 | N. | Def. | +++ | ++ | ++ | ++ | + | + | +++ | + | New attacks 5 & 6 mo. later during infections |
| | | | | L. E. | 1/∞ | 0 | Def. pr. | .. | +++ | ++ | +++ | +++ | + | + | +++ | + | |
| 6 | 23 | M | 12 | R. E. | 0.8 | 0.2 | N. | Def. | + | + | + | + | — | — | + | — | |
| | | | | L. E. | 1.0 | 1.0 | N. | N. | + | + | — | + | — | — | — | — | |
| 7 | 38 | M | 11 | R. E. | 0.15 | 0 | Def. | .. | +++ | +++ | ++ | +++ | + | + | +++ | ++ | New hemorrhage after 4 mo. in blind eye |
| | | | | L. E. | 0.4 | 0.4 | Def. | Def. | +++ | ++ | — | +++ | + | — | — | + | |
| 8 | 17 | M | 7 | R. E. | 1.0 | 1.0 | N. | N. | + | — | + | ++ | — | + | + | — | Diabetic lens opacities, more in L. E. |
| | | | | L. E. | 0.5 | 0 | N. | .. | + | — | — | + | — | — | — | — | |
| 9 | 35 | M | 7 | R. E. | 0.8 | 1.0 | N. | Def. | ++ | + | + | ++ | + | ++ | —? | + | New hemorrhage after 6 mo. during infection |
| | | | | L. E. | 1/∞ | 0 | Def. pr. | .. | +++ | +++ | +++ | +++ | + | +++ | +++ | ++ | |
| 10 | 24 | F | 3 | R. E. | 1/∞ | 0 | Def. pr. | .. | +++ | +++ | +++ | +++ | Removed | | | | Subcapsular lens opacities in both eyes; evisceration of the R. E. owing to perforating lesion |
| | | | | L. E. | 0.6 | 0.8 | N. | Def. | ++ | ++ | + | +++ | + | + | + | + | |

* N. indicates normal; def., defective; pr., projection; other symbols as in Table 1.

drug therapy were first recommended, then hypophysectomy, but the patient was unwilling to submit to the latter. A couple of months later his vision had deteriorated further to hand movements R. E. and finger-counting L. E. Like many others (Case 3), he wanted the operation only at this last hopeless phase. However, only Case 3 was operated on when the patient was already practically blind; at the last examination her vision in the better eye had already deteriorated to 0.2, but even then the patient waited for another two months.

## Therapy

The hypophysectomy by frontotemporal approach described by Luft and Olivecrona[22] was performed by one of us (G. af B.) at the Red Cross Hospital. For reasons of operative technique the optic nerve of the worse eye was severed in eight cases. One of us (C. A. H.) made the preoperative endocrinological examination and was responsible for the postoperative treatment of the patient at the Maria Hospital. The maintenance substitution therapy consisted of small doses of cortisone, desiccated thyroid, and sexual hormones but no deoxycorticosterone (Doca).[11]

## Results

Nine of the patients were alive after a follow-up period of 3-34 months. Case 2 died three and one-half months postoperatively from a brain abscess originating from a silk fistula.

The hypophysectomy, judging by the changes in hormonal pattern, was complete or almost complete in all the cases.

After the initial postoperative difficulties (hypoglycemia, epileptiform cramps, etc.), the diabetes became easier to control and the need for insulin was reduced by approximately one-half. Endogenous creatinine clearance had not deteriorated, a finding that speaks for the assumption that Kimmelstiel-Wilson nephropathy had not progressed. Proteinuria, moreover, had cleared in three patients. (Detailed endocrinological results are published in *Acta endocrinologica scandinavica*.[18])

*Vision and Visual Fields.*—In seven patients the vision of the better eye remained unchanged or improved a little during the follow-up period (Table 2). On the other hand, it deteriorated in three patients (Cases 1, 3, and 5). In one of these (Case 3), impairment of vision was noticed immediately after operation; in two (Case 3 and 5) it was due to relapses after initial improvement. The patients often reported subjective improvement of vision which could not be verified in the vision test.

In the eight cases where is was necessary to sever the optic nerve, the eye involved had been considered lost as regards vision before operation in six (seven) patients. Five cases showed a partial temporal defect postoperatively in the visual field of the better eye. The patients themselves failed to notice this serious complication. It can obviously be avoided by developing the method.

Partial loss of peripheral vision and possible relapses postoperatively raise doubts about the value of the operation. Table 3 shows the impairment of vision in the poorer

TABLE 3.—*The Impairment of the Vision Before and After Hypophysectomy*

| | Poorer Eye | | | Better Eye | |
|---|---|---|---|---|---|
| Case | Time of Visual Impairment, Mo. | Vision Before Operation | Vision Before Operation | Postoperative Observation Time, Mo. | Vision at Last Visit |
| 1 | 4 | H. M. | 0.8 | 34 | 0.2 |
| 2 | — | 0.25 | 1.0 | 3 * | 1.0 |
| 3 | 15 | H. M. | 0.2 ? | 24 | $\frac{1}{\infty}$ |
| 4 | 3 | F. C. 0.5m. | 1.0 | 19 | 1.3 |
| 5 | 12 | $\frac{1}{\infty}$ | 0.3 | 14 | 0.1 |
| 6 | 2 | 0.8 | 1.0 | 12 | 1.3 |
| 7 | 4 | 0.15 | 0.4 | 10 | 0.4 |
| 8 | 5 | 0.5 | 1.0 | 7 | 1.0 |
| 9 | 18 | $\frac{1}{\infty}$ | 1.0 | 6 | 1.0 |
| 10 | 4 | $\frac{1}{\infty}$ | 0.6 | 3 | 0.8 |

* Patient died 3 ½ months after the operation.

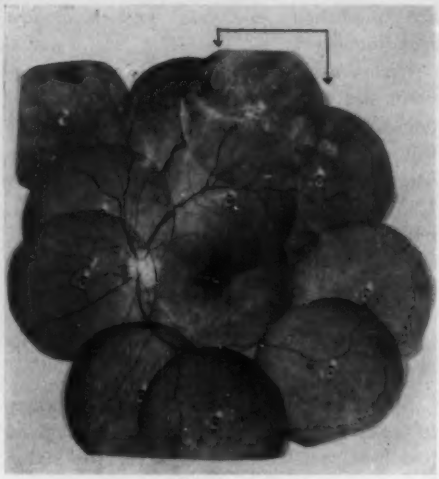


Figure 1

Fig. 1 (Case 1).—Left fundus Jan. 26, 1956. Fresh proliferative changes and bigger hemorrhages

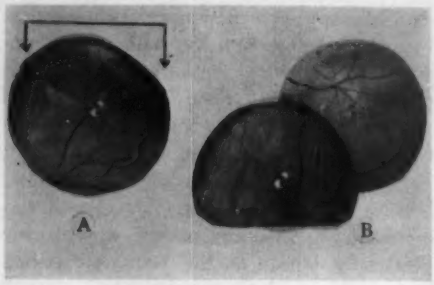



Figure 2

are partly visible in upper middle periphery. Newly formed and dilated capillaries and capillary aneurysms and hemorrhages exist in the semicircle on the temporal side and below.

Fig. 2 (Case 1).—Left fundus two months after hypophysectomy was nearly as before, but *A*, the fresh exudates above, compared with those in Figure 1 (arrows), have diminished and are more restricted; *B*, the capillary network around the inferior venous branches has regressed.

eye before operation and the potential visual deterioration of the better eye before and after operation. The Table supports the view that deterioration of vision is either checked or retarded after hypophysectomy; some cases even revealed a slight improvement of vision.

*Intraocular Pressure.*—Not a single eye developed secondary glaucoma postoperatively.

*Fundal Changes.*—Comparison of the development of fundal changes obviously gives a more accurate idea than vision of the value of the operation (Table 2). Changes in the fundus of the eye were also followed by means of photographs.

Fundal changes generally diminished postoperatively, even in the three cases in which vision deteriorated. Two of them (Cases 1 and 5) showed a notable improvement both

Fig. 3 (Case 1).—Four months after the operation new hemorrhages appeared, and proliferative changes have slowly advanced.

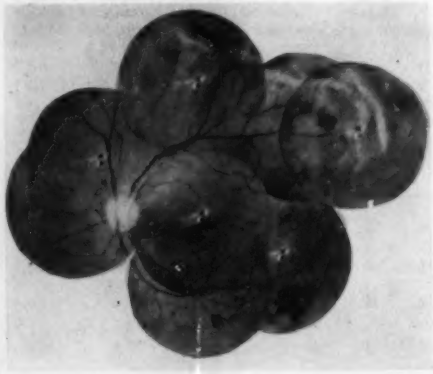
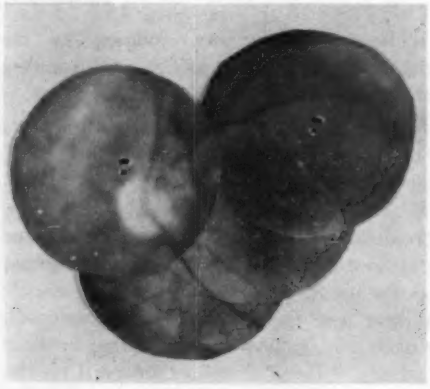


Fig. 4 (Case 1).—Profuse preretinal hemorrhage and retinal edema appeared nearly six months after the operation. At the phase of resorption six weeks later the formation of the exudate stripe began near the fovea.



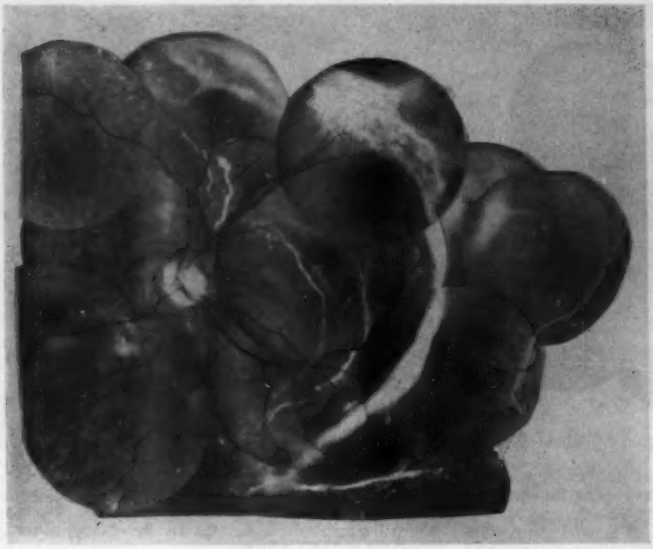


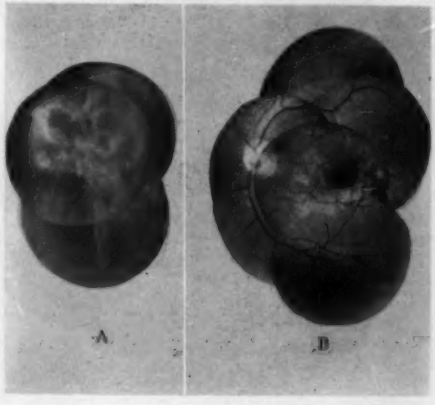
Fig. 5 (Case 1).—Left fundus, two years eight months after the operation, shows only very few and small hemorrhages. In the macular area and above the disc are seen "hard" exudate stripes with very little tendency to shrink. In middle periphery the proliferative changes are in the same area in which they and the new capillary formations were noticed before the operation. In the temporal periphery there is again a "hard" strand.

in fundal changes (Figs. 1 and 2) and in vision two months after operation, but new hemorrhages (Fig. 3) appeared four to six months postoperatively in connection with infections. In the third (Case 3) the changes in the left fundus (because of cataract the fundal changes in the right eye were not visible) also decreased gradually, and two years later the hemorrhages and exudates had become resorbed. Newly formed vessels had diminished, and the cluster-like aneurysms had disappeared or changed to whitish spots. Vision, however, failed to improve, obviously because of atrophy of the optic nerve and the partial proliferation-induced ablation in the upper part of the retina.

The *hemorrhages* existing preoperatively had become absorbed either entirely or for the greatest part in all the patients (Figs. 1, 5, and 6). Postoperative recurring hemorrhage occurred in the two patients (Cases 1 and 5) already mentioned and, moreover, in the better eye of one (Case 9) (Fig. 11) and in the blind eye of another (Case 7). The hemorrhages occurred in areas where neovascularization was observed prior to surgery.

*Waxy exudates and cotton-wool patches* were absorbed gradually after the operation (Figs. 7-9 and 12). It is worthy of note that, e. g., in Case 1 where strands of exudate were observed in the central parts of the fundus after recurring hemorrhages they showed no neovascularization or connective

Fig. 6 (Case 4).—*A*, right fundus one and one-half years after the operation. The massive proliferative changes were as before the operation, but the numerous hemorrhages were absorbed. *B*, left fundus one and one-half years after the operation seemed nearly normal. The hemorrhages and capillary aneurysms lying over the disc and in the macular area before the operation have disappeared. Vision was 1/3.



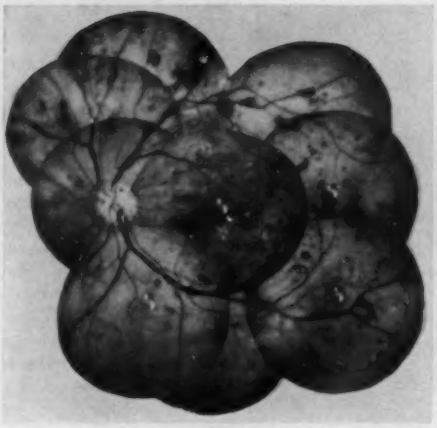


Figure 7

Fig. 7 (Case 7).—The left fundus before the operation is slightly edematous. The venules are engorged with variations in the caliber of the lumen and macroaneurysms. All around the fundus are numerous hemorrhages of different sizes and

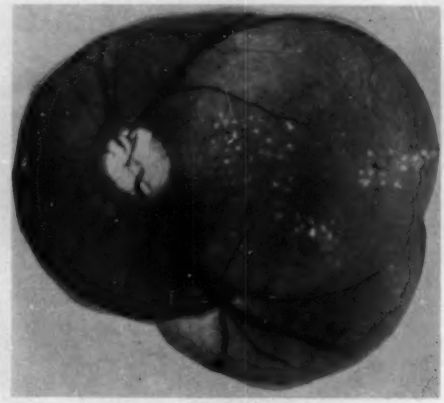


Figure 8

capillary aneurysms. Exudate spots are visible especially in the macular area.

Fig. 8.—The same fundus four months after the operation. Hemorrhages partly absorbed, the finest cluster-like capillary aneurysms over the macula have disappeared. Exudates in the macular area resemble a "star figure."

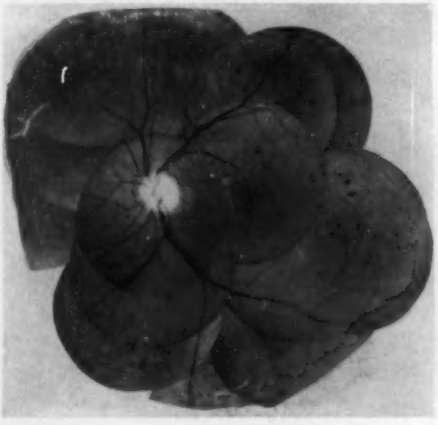
tissue proliferation in the course of two years (Figs. 4 and 5); nor was there any of the usual typical shrinking of these strands. On the other hand, in the middle periphery where the newly formed vessels had been visible previously the development proceeded as usual (Figs. 1 and 5), although obviously more slowly.

*Proliferations* existing before the operation seemed to be more resistant. Incipient proliferation seemed to disappear in only two cases (Cases 4 and 9), and in one (Case 1) it disappeared temporarily.

*Venous Changes.*—We found that after the operation the retinal edema and engorged venules began to regress. Even the

Fig. 9 (Case 7).—The same fundus nine months after the operation. No edema is visible. The macroaneurysms have disappeared, the hemorrhages are markedly diminished; no star figure. At 6 and 10 o'clock in the periphery there are seen

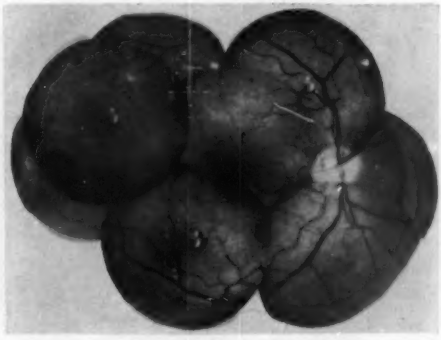
Figure 9



yellowish, glistening sheets around the precapillaries.

Fig. 10 (Case 9).—Right fundus four months before the operation with slight edema and engorged venules. Note the preretinal hemorrhage at 8 o'clock and beginning proliferation with capillaries under the disc.

Figure 10



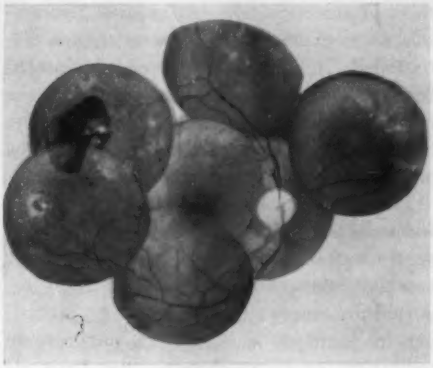


Fig. 11 (Case 9).—Right fundus seven months after hypophysectomy. Edema and engorgement of venules regressed. There appeared one new hemorrhage evidently in connection with hypoglycemia attacks during infection. Other hemorrhages (e. g., that at 8 o'clock) and capillary aneurysms have changed to yellowish dots or disappeared. Under the disc is seen the sheathing of arteriole only.

local venous bulges, the macroaneurysms, began to shrink and disappeared, or there appeared white, well-defined deposits (Figs. 7, 9, and 12). The networks of dilated capillaries with microaneurysms and aneurysmal clusters and the newly formed, sometimes wide vessels disappeared at times (Figs. 7-9 and 12) or cicatrized (Figs. 10 and 11). Two patients showed sheathing of precapillaries (Figs. 9 and 11). In Case 9 the networks of dilated or newly formed capillaries turned into a lustrous yellowish web (Figs. 10 and 11).

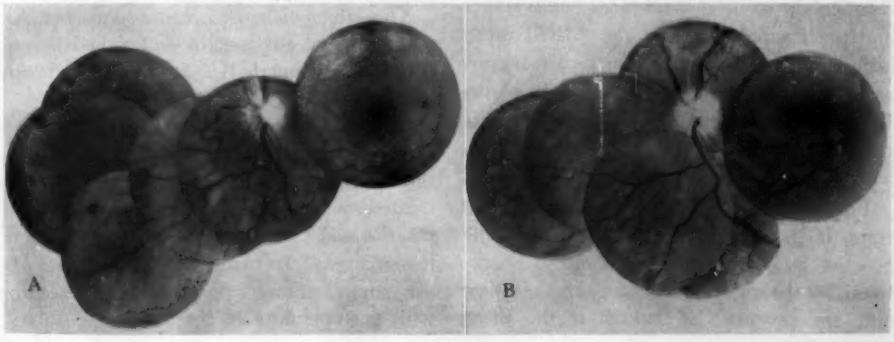
Ophthalmoscopically complete disappearance of venous changes occurred in three patients in whom these changes were fairly small preoperatively. If the changes on the venous side were extensive and far-advanced, their regression was obvious but, at least so far, incomplete. The newly formed vessels and capillary aneurysms seemed to disappear most reluctantly in the area of the middle periphery and especially in the temporal portion (Fig. 9). It was just there that the hemorrhage recurred in three cases (Fig. 11).

## Comment

Most authors seem to hold that impairment of vision generally ends after hypophysectomy and the process becomes less active and that retinopathy hardly progresses at all. The hemorrhages tend to become absorbed and recur more rarely.[10,16,20,21,26,27]

Kinsell,[17] in whose material three of nine patients survived for over one year, came to a more negative conclusion of the effect of hypophysectomy. He considered it impossible to know whether the operation had retarded the progress of retinopathy and was also uncertain whether, in view of the unavoidable hazard it involves, hypophysectomy should be attempted at all, even in cases where other therapeutic procedures have failed.

Fig. 12 (Case 10).—*A*, left fundus two months before the operation. Note tortuous, engorged, and newly formed vessels, dilated capillary network with aneurysms, and cotton-wool patch nasally from the disc. *B*, left fundus three months after hypophysectomy. The vascular changes mentioned are regressed, hemorrhages diminished. The cotton-wool patch nasally and exudates under the disc disappeared.



Significantly typical of proliferative diabetic retinopathy are ophthalmologically discernible venous changes (Kornerup [18]). Engorgement and tortuosity of venules have been found clinically, also variation of caliber and ampulla-like dilatations (macroaneurysms) of the venules.[12] With these findings are associated the capillary dilatation on the venous side and microaneurysms attributed to venous stasis and the peculiar structure of the retinal capillary network.[2,24] The ophthalmoscopically well-defined "hemorrhages" are all microaneurysms; the irregular hemorrhages appear to arise either by diapedesis through the aneurysmal wall or by rupture of the capillary aneurysm.[2-4,9] Janert,[15] from clinical observations of the fundi of 5,000 diabetics, considered just the dilatated capillaries with their cluster-like aneurysms (Flohstichartige Blutungen) as an indication of the malignity of the disease. Several of our patients had plenty of them before the operation. They tended to regress after hypophysectomy, most slowly, however, at the peripheral branches of the tributaries, which could be caused by stasis.

Our observation was that the changes of the venules and capillaries and the newly formed vessels seemed to hold a key position even after hypophysectomy. Firstly, new hemorrhages were possible in this particular area, even after hypophysectomy. Secondly, the changes on the venous side might regress, even disappear, after hypophysectomy.

It would be important to know how often and how completely the positive changes mentioned, namely, narrowing of venules and the disappearance of the dilated capillaries and the micro- and macroaneurysms and the newly formed vessels, really occur. In the literature on this point the changes occurring in the fundus of the eye seem to have been dismissed somewhat summarily.

Luft et al.,[21] however, could follow 10 fundi in their patients. In one of them the process had progressed, obviously aggravated by rheumatoid arthritis. In the other nine the process had halted, if the three cases of new hemorrhages from the new vessels formed prior to the operation are disregarded. In 5 of the 10 cases newly formed vessels had decreased. In one case the proliferations also diminished considerably. Schimek, on the other hand, regarded the proliferative changes as irreversible.

Luft et al. noted the decrease of newly formed vessels, but no posthypophysectomy regression of the other typically diabetic vascular changes mentioned has been reported previously. On the contrary, according to Javid et al.,[16] it does not reverse permanent vascular changes that have already occurred. In our opinion, the present material indicates that the vascular process alleviates its malignant character after hypophysectomy, since the venous changes characteristic of proliferative diabetic retinopathy tend to regress and disappear after the operation.

## Summary

One eye was practically blind in most of the ten operated-on patients, and vision on the better eye was seriously threatened by the proliferative changes. Fundal changes advanced despite control of the diabetes and other therapeutic procedures.

The optic nerve of the worse eye was severed near the chiasm for reasons of technique except in two cases. Five of these cases also showed postoperatively a temporal defect in the visual field of the better eye.

The time elapsing from the operation to the last follow-up ranged from 3 months to 2 years 10 months.

The labile diabetes became more benign, and the need for insulin diminished to approximately one-half. Proteinuria disappeared in three patients.

Central vision in the better eye remained unchanged or improved somewhat during the follow-up period in the seven surgically treated patients. In three cases vision deteriorated postoperatively because of new hemorrhages. In two of these three patients the complications appeared in connection with postoperative infections.

The following changes seemed typical of the disease process in the fundi after the hypophysectomy:

(1) Vascular changes: dilatation of venules and capillaries tended to regress and micro- and macroaneurysms seemed to disappear and the same applied to the newly formed vessels.

(2) Existing hemorrhages were absorbed and the bleeding tendency diminished. Even a massive hemorrhage could be absorbed and dry into shiny patterns and crystals.

(3) Waxy exudates and cotton-wool patches also tended to disappear.

(4) The rate of proliferation diminished. The strands that developed after recurrent hemorrhages were dry-looking and situated deep in the retina, and, if newly formed vessels were absent, no shrinkage was observed.

Certain positive changes notwithstanding, it must be emphasized that the risk involved is considerable, and constant attention must be paid in postoperative care both to the hormone-electrolyte balance and to the danger of infections. Although the patients of this type have an extremely gloomy prognosis, it is not yet possible to make a final evaluation of hypophysectomy as a clinical therapeutic method against proliferative diabetic retinopathy.

P. Ranta 10A.

## REFERENCES


1. Andersson, E., and Kjerulf, K.: Hypofysektomi ved svær diabetes med udtaltretinopathi, Ugesk. læger 120:700-702, 1958.
2. Ashton, N.: Vascular Changes in Diabetes with Particular Reference to the Retinal Vessels: Preliminary Report, Brit. J. Ophth. 33:407-420, 1949.
3. Ashton, N.: Injection of the Retinal Vascular System in the Enucleated Eye in Diabetic Retinopathy, Brit. J. Ophth. 34:38-41, 1950.
4. Ballantyne, A. J., and Loewenstein, A.: Retinal Micro-Aneurysms and Punctate Haemorrhages, Brit. J. Ophth. 28:593-598, 1944.
5. Becker, B.: Diabetic Retinopathy, Ann. Int. Med. 37:273-289, 1952.
6. Becker, B.; Lang, C. A., and Chow, B. F.: Vitamin B-12 Excretion of Diabetic Retinopathy, J. Clin. Nutrition 1:417-423, 1953.
7. Becker, B.; Maengwyn-Davies, G. D.; Rosen, D.; Friedenwald, J. S., and Winter, F. C.: The Adrenal Cortex and B-Vitamins in Diabetic Retinopathy, Diabetes 3:175-187, 1954.
8. Chabanier, H.; Puech, P.; Lobo-Onell, C., and Lélu, E.: Hypophyse et diabète, Presse mèd. 44:986-989, 1936.
9. Friedenwald, J. S.: Diabetic Retinopathy, J. A. M. A. 150:969-971, 1952.
10. Gordon, E. S.: Surgical Hypophysectomy in Treatment of Diabetic Nephropathy, J. Lab. & Clin. Med. 48:810-811, 1956.
11. Heinsius, E.: Durchblutunsstörungen der Netzhaut des Diabetikers, Klin. Monatsbl. Augenh. 125:1-5, 1954.
12. Heinsius, E.: Retinopathia diabetica bei Kindern, Klin. Monatsbl. Augenh. 129:499-505, 1956.
13. Hernberg, C. A.; af Björkesten, G., and Vannas, S.: Hypophysectomy in Treatment of Retinopathy and Nephropathy in Severe Juvenile Diabetes, Acta endocrinol. scandinav., to be published.
14. Ikkos, D.; Luft, R., and Gemzell, C.: Effect of Human Growth Hormone in Man, Lancet 1:720-721, 1958.
15. Janert, H.: Zur Retinopathia proliferans diabetica, Klin. Monatsbl. Augenh. 131:633-640, 1957.
16. Javid, M.; Gordon, E. S., and Erickson, T. C.: Hypophysectomy in Severe Diabetes: Neurosurgical Aspects, J. Neurosurg. 15:504-511, 1958.
17. Kinsell, L. W.: Hypophysectomy in Unstable Diabetics with Progressive Renal and Retinal Disease, Bull. New York Acad. Med. 33:171-174, 1957.
18. Kornerup, T.: Retinopathia diabetica proliferans, Acta ophth. 36:87-101, 1958.
19. Leopold, I. H.: Therapy of Vascular Lesions of the Fundus, Proc. Inst. Med. Chicago 21:255-271, 1957.
20. Luft, R.; Ikkos, D.; Gemzell, C. A., and Olivecrona, H.: Effect of Human Growth Hormone in Hypophysectomised Diabetic Subjects, Lancet 1:721-722, 1958.
21. Luft, R., and Olivecrona, H.: Experiences with Hypophysectomy in Man, J. Neurosurg. 10: 301-316, 1953.
22. Luft, R.; Olivecrona, H.; Ikkos, D.; Kornerup, T.; Ljunggren, H.; Nilsson, L-B., and Sjögren, B.: Hypophysectomy in Severe Juvenile Diabetes Mellitus, Nord. med. 55:715-719, 1956.
23. Luft, R.; Olivecrona, H., and Sjögren, B.: Hypophysectomy in Man, Nord. med. 47:351-354, 1952.

24. Lukens, F. D. W., and Dohan, F. C.: Experimental Pituitary Diabetes of 5 Year's Duration with Glomerulosclerosis, Arch. Path. 41:19-24, 1946.

25. Michaelson, I. C., and Campbell, A. C. P.: The Anatomy of the Finer Retinal Vessels, and Some Observations on Their Significance in Certain Retinal Disease, Tr. Ophth. Soc. U. Kingdom. 60:71-110, 1940.

26. Recant, L., and Hartroft, W. S.: Surgical Hypophysectomy for Diabetic Retinopathy, Am. J. Med. 22:949-960, 1957.

27. Schimek, R. A.: Hypophysectomy for Diabetic Retinopathy, A. M. A. Arch. Ophth. 56:416-425, 1956.

28. Slater, J. D. H., and Nabarro, J. D. N.: Hypophysectomy for Incipient Blindness Due to Progressive Diabetic Retinopathy, Proc. Roy. Soc. Med. 51:365, 1958.

# The Treatment of Ophthalmic Herpes Zoster with Protamide

G. SCASSELLATI SFORZOLINI, M.D., Bologna, Italy

The great variety of remedies which are available for use in the treatment of herpes zoster is an indication in itself of the limited value of these products. It is evident that none has antiviral activity. Surgical procedures as well as medicosurgical and physical-therapeutic measures are at times suggested for the control of the acute phase of the disease. I believe a more conservative approach to the problem is desirable and the radical methods should be exclusively reserved for the unduly disturbing postherpetic symptoms. Even in such instances, they should be used only after other therapies have failed.

In a critical evaluation of such remedies, it is important to consider that many may induce toxic or at least undesirable reactions. These effects may occur because of the inherent nature of the agents, their mechanism of action, or multiple pharmacologic actions.

Since the drugs currently employed have therapeutic limitations in herpes zoster and as many may also have undesirable side-effects, it is my opinion that any drug purported to be beneficial which is easy to administer and nontoxic should be given a clinical trial and the findings published to encourage others to investigate in additional and more extensive studies.

Protamide (Sherman Laboratories, Detroit), a proteolytic enzyme prepared from hog stomach, has been successfully used for about three years in this clinic in patients affected by herpes zoster involving the first branch of the trigeminal nerve. Protamide is an injectable sterile colloidal solution (pH 6.5). The colloid, the active fraction, is a modified proteolytic enzyme derived from the glandular layer of hog stomach and denatured by incubation at constant temperature.

Submitted for Publication Jan. 8, 1959.

From the Eye Clinic of the University of Bologna.

The toxicology of the product has been studied by Lehman et al.[1] In 1947, Costello[2] reported on its use in tabes dorsalis. Marsh,[3] in 1950, employed the preparation to control the pain associated with herpes zoster. The preparation proved especially beneficial for the control of pain. Moreover, it hastened healing of lesions and influenced favorably the course of the disease. These results were confirmed by Combes and Canizares[4] and by Lehrer et al.[5]

Protamide was also found to be beneficial for other neuritic conditions. Smith[6] treated patients having neuritis presumed to be of viral origin. There was some suspicion that a certain number may have had herpetic infection without appearance of lesions. Twelve cases of spinal nerve root pain of diverse etiologies were treated by Love.[7]

Another report by Lehrer et al.[9] on the therapeutic effectiveness of Protamide in some cases of varicella is of notable interest because of the close interrelation between the viruses associated with chicken pox and herpes zoster. Pruritis, fever, and subjective discomfort were promptly controlled, and the course of the disease was significantly shortened.

A search of ophthalmologic and other medical literature did not reveal any publication on the use of Protamide in zosterian infection involving the ophthalmic branch of the fifth cranial nerve. It does not follow that Protamide had to be effective in

*Summary of Case Reports of*

| Case No. | Age | Sex | Duration of Eruptions Prior to Therapy, Days | Vision | | Skin Lesions | | Conjunctivitis | | Episcleritis | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Before Treatment | After Treatment | Nerve Involved (Ophthalmic Br. of V) | Healed, Days * | Severity | Healed, Days * | Severity | Healed, Days * |
| 1 | 38 | M | 4 | 10/10 | 10/10 | Frontal | 5-6 | 2+ | 3 | -- | -- |
| 2 | 22 | M | 3 | 10/10 | 10/10 | Frontal | 4-5 | -- | -- | -- | -- |
| 3 | 56 | F | 3 | 9/10 | 9/10 | Frontal | 5-6 | -- | -- | -- | -- |
| 4 | 55 | M | 6 | 7/10 | 10/10 | Frontal & ext. nasal | 5-6 | 2+ | 4 | -- | -- |
| 5 | 76 | M | 30 | 3/10 | 6/10† 9/10‡ | Absent § | -- | 3+ | 4 | -- | -- |
| 6 | 45 | M | 2 | 10/10 | 10/10 | Frontal | 4-5 | -- | -- | -- | -- |
| 7 | 16 | F | 5 | 10/10 | 10/10 | Lacrimalis | 5-6 | 2+ | 2 | -- | -- |
| 8 | 62 | M | 5 | 10/10 | 10/10 | Frontal | 5-6 | -- | -- | -- | -- |
| 9 | 32 | F | 1 | 10/10 | 10/10 | Frontal | 8-10 | 2+ | 3 | 2+ | 7 |
| 10 | 28 | M | 6 | 9/10 | 10/10 | Frontal & ext. nasal | 6-7 | 2+ | 3 | -- | -- |
| 11 | 57 | F | 3 | 1/10 | 10/10 | Frontal | 8 | 4+ | 5-6 | -- | -- |
| 12 | 72 | M | 5 | 10/10 | 10/10 | Frontal | 5-6 | -- | -- | -- | -- |
| 13 | 46 | M | 1 | 9/10 | 10/10 | Frontal | 4-5 | 4+ | 5 | 3+ | 7 |
| 14 | 33 | F | 3 | 7/10 | 10/10 | Frontal | 5 | 2+ | 3 | -- | -- |
| 15 | 58 | F | 10 (Recur) | 10/10 | 10/10 | Absent | -- | -- | -- | -- | -- |

* Number of days after initiation of Protamide therapy; †After 4 days; ‡ After 20 days; § After 26 days, when patient was cured.

this ophthalmic condition because it proved of value in herpetic infections localized at other sites. The involvement of the external and internal membranes and of the optic nerve itself could place ophthalmic herpes in a rather different clinical category and, as a consequence, change the therapeutic problem.[10] Hence, a therapeutic trial appeared justified.

This report presents our experience with the use of Protamide in 15 patients with ophthalmic herpes. The series includes only cases on whom detailed information could be obtained on the course of the disease prior to and after the treatment. Patients who did not return after receiving the first series of injections are excluded. It may be presumed these patients required no further treatment.

Protamide (1.3 cc.) was injected daily for three consecutive days and thereafter at intervals of one or more days until pain and lesions disappeared. Other therapies were used concurrently in a few patients primarily to treat severe ocular lesions accompanying the herpetic infection. Local and systemic reactions were entirely absent after the administration of Protamide in our patients. The results and case reports are summarized in the Table.

## Comment on Results

Protamide proved of unquestionable value for treatment of ophthalmic herpes as was evidenced by the favorable response observed in all instances. In particular, pain was always alleviated, subsiding after the first few injections and at times even after the first one. Another important fact which should not be overlooked is that none of the patients experienced painful postherpetic neuralgia. This is most important, since the herpes zoster sequelae can be serious and are oftentimes resistant to all treatment.

The lesions were favorably influenced. The vesicles dried faster and the crusts fell off more quickly than in the nontreated patients. It was also apparent that the rapid resolution of lesions was responsible for the marked reduction in the amount of residual cutaneous scarring.

The conjunctivitis occurring in 9 of the 15 cases regressed quickly (in a period of

*PROTAMIDE TREATMENT*

*Patients Treated with Protamide*

| Keratitis | | Iridocyclitis | | Pain | | | | |
|---|---|---|---|---|---|---|---|---|
| Severity | Healed, Days * | Severity | Healed, Days * | Severity | No. Injections Required to Relieve | Total Injections of Protamide | Recurrence | Postherpetic Neuralgia |
| -- | -- | -- | -- | 3+ | 2 | 3 | None | None |
| -- | -- | -- | -- | 3+ | 2 | 4 | None | None |
| -- | -- | -- | -- | 4+ | 2 | 4 | None | None |
| 3+ | 8 | 1+ | 4 | 3+ | 3 | 6 | None | None |
| 3+ | 5 | 3+ | 4 | 4+ | 2 | 4 | Questionable | Questionable |
| -- | -- | -- | -- | 2+ | 1 | 3 | None | None |
| -- | -- | -- | -- | 3+ | 3 | 4 | None | None |
| -- | -- | -- | -- | 3+ | 2 | 5 | None | None |
| -- | -- | -- | -- | 4+ | 3 | 5 | None | None |
| 3+ | 6 | -- | -- | 4+ | 5 | 6 | None | None |
| 4+ | 10 | 2+ | 6 | 4+ | 3 | 9 | None (Some skin paresthesia for 3 mo.) | None |
| -- | -- | -- | -- | 4+ | 2 | 6 | None | None |
| -- | -- | -- | -- | 3+ | 1 | 3 | None | None |
| 3+ | 7 | -- | -- | 4+ | 1 | 6 | None | None |
| 2+ | 3 | -- | -- | 3+ | 3 | 6 | -- | -- |

two to six days). It subsided much faster in Cases 1 and 7 in which the complication represented a simple reaction to the cutaneous eruptions. The conjunctival inflammation was not very severe in the latter cases.

Episcleritis in Cases 9 and 13 and keratouveitis in Cases 4, 5, 10, 11, and 14 did not respond as readily. In these two conditions Protamide did not prove too effective for control of the inflammatory processes. To hasten healing of these ocular complications, supplemental therapy was employed in all but one case (Case 10).

The progress of the inflammatory processes and, conversely, the degree of healing depend to a large extent upon two important factors: first, the virulence of the virus, and second, the resistance of the tissues. These factors are more important in determining the course of the ocular complications than the possible therapeutic effectiveness of any available medicament.

Keratitis in some instances showed improvement before treatment was initiated (Case 11). It is of interest that the keratitis present in Case 15 (recurrence of ophthalmic herpes zoster complicated by corneal lesions) healed very satisfactorily with the use of Protamide alone.

In general, satisfactory and rapid resolution of the keratouveal and episcleral lesions without appreciable residual scarring and, most important, without relapse or recurrences were noted. Some cases, for instance, Cases 4 and 5, were treated with too few injections in proportion to the severity of the condition. This was due in part to the high cost of the drug in this country and in part to our initial inexperience. We believe a more prolonged treatment may be employed without fear in those cases complicated by ocular lesions. Protamide has proved to be lacking in any toxicity even in elderly people.

The severer and more complicated cases may be treated with Protamide alone, since the antibiotics are useless except when a superimposed infection is suspected. However, the local use of antibiotics is indicated; the mydriatic drugs should always be employed, and cortisone (solution, ointment, or subconjunctival injection) is recommended after the acute phase of the disease or in the loss of corneal tissues.

The combined administration of thiamine (vitamin $B_1$) and cyanocobalamin (vitamin $B_{12}$) is superfluous, since Protamide possesses marked neurotrophic activity.

One of the typical case histories may be discussed.

CASE 14.—A 33-year-old cleaner, from Piamoro, Bologna. March 16, 1957: Five days prior to examination, erythema occurred on left side of forehead, which was accompanied by sharp pain radiating to the left side of the head. Two days later, vesicles appeared on the same side of the forehead, the surrounding scalp, and upper eyelid.

Vision, left eye: 7/10. Examination, left eye: moderate conjunctival hyperemia. A corneal paracentral subepithelial infiltrate with smooth, rounded contour was seen. Another corneal paralimbic infiltrate was observed at 5-6 o'clock, which was ulcerated and showed branching with infiltration and edema of the borders. Another small paralimbic corneal ulceration was evident at 11 o'clock which was surrounded by nebulae and penetrated by a group of small vessels. No deposits were apparent on Descemet's membrane; the aqueous humor contained some floaters; the iris and lens appeared normal. Fundus, left eye: somewhat cloudy, no pathology. Left eye pressure normal on digital palpation. There was corneal anesthesia. Three ampules of Protamide and local application of 1% atropine solution twice daily were prescribed.

March 19, 1957: The pain subsided completely after the first injection, the eruptions had markedly regressed, conjunctiva was no longer hyperemic, and one of the ulcerated corneal infiltrates had healed. Three more ampules of Protamide were prescribed.

March 21, 1957: The eruptions had healed completely. There was a residual ulcerated corneal infiltrate. Topical applications of chlortetracycline (Aureomycin) ointment and oxytetracycline (Terramycin) ointment three times a day were prescribed.

March 23, 1957: The corneal lesions had healed, and the aqueous humor was clear. Vision, left eye: 10/10.

March 25, 1957: Examination, left eye: an occasional corneal nebula and slight corneal hypesthesia. Local treatment was discontinued.

Recurrence and postherpetic neuralgia did not follow.

Contrary to the conclusions of other investigators, I did not notice any significant interrelationship between the degree of response obtained and promptness of treatment after onset of the disease. It would appear judicious, however, to start treatment as early as possible.

Different hypotheses have been advanced to explain the mechanism of action of the drug, but none of these is based on elements of certainty.

In conclusion, more satisfactory results were obtained with Protamide than with those drugs previously employed, such as neurovaccines, antibiotics, vitamins, corticotropin (ACTH), and cortisone.

*Giornale Italiano di Oftalmologia* gave permission to use translations of parts of the text from an earlier report.[21]

Eye Clinic, University of Bologna.

## Addendum

Since the preparation of this report, the number of patients has increased to 42, with 90% having good to excellent results.

## REFERENCES

1. Lehman, A. J.; Chase, H. F., and Yonkman, F. F.: Pharmacologic Study of Protamide, Urol. & Cutan. Rev. 48:378, 1944.

2. Costello, R. T.: New Treatment for the "Lightning Pains" of Tabes Dorsalis, Urol. & Cutan. Rev. 51:260, 1947.

3. Marsh, W. C.: Treatment of Herpes Zoster with Protamide, U. S. Armed Forces M. J. 1:1045, 1950.

4. Combes, F. C., and Canizares, O.: Herpes Zoster: Its Treatment with Protamide, New York J. Med. 52:706, 1952.

5. Lehrer, H. W.; Lehrer, H. G., and Lehrer, D. R.: Clinical Evaluation of Protamide in Sensory Nerve Root Inflammations and Allied Conditions, Northwest Med. 54:1249, 1955.

6. Smith, R. T.: Treatment of Neuritis with Protamide, New York Med. 8:16, 1952.

7. Love, T. R.: Spinal Root Nerve Pain, Rocky Mountain M. J. 50:873, 1953.

8. Reference deleted by author.

9. Lehrer, H. W.; Lehrer, H. G., and Lehrer, D. R.: A New Treatment for Chickenpox and Other Virus Diseases: Preliminary Report, Ohio M. J. 47:44, 1951.

10. Cavara, V., and Bietti, G. B.: Le Manifestazioni oculari delle malattie da virus e da rickettsie, Bologna, Casa Editrice L. Capelli, 1952.

11. Scassellati Sforzolini, G.: Il Trattamento dell' "herpes zoster" oftalmico con neuramide, Gior. ital. oftal. 10:490, 1957.

# ERG of Congenital Totally Color-Weak Eye Accompanied by Lesion of Optic Nerve

TAKASHI A. SUZUKI, M.D., Morioka, Japan

A number of investigators have already used the electroretinogram (ERG) for studying color deficiency. Among them, Armington [1] (1952) reported that in the case of protanopes the ERG elicited by the red-light stimulus is lacking in the *x*-wave, which was first described by Motokawa and Mita [2] (1942). On the other hand, Vukovich [3] (1952) reported that under all conditions of stimulation of the totally color-blind eye a complete absence of the *x*-wave was apparent as well as a highly reduced *a*-wave and a less pronounced reduction of the *b*-wave. These electroretinographic studies on the subject with anomalous color vision were useful not only for analysis of the normal ERG but also for investigating the mechanism of color disability. Thus, it might be of value to settle the question whether the cause of anomalous color vision lies in the retina or in any optic pathways or higher centers.

I had the opportunity to investigate an extremely rare case of a congenital totally color-weak subject, whose one eye had a traumatic injury of the left optic nerve, whereas the other eye remained intact. The ERG's (*a*-wave, *b*-wave, and *x*-wave) were recorded from the two eyes of this patient under various conditions of stimulation. A comparative study of the patient's two eyes and of a normal trichromat's eye are reported in this paper.

## Report of Case

The subject examined was a 43-year-old married man. He has been since childhood aware of color confusion, especially between red and green colors, but nystagmus, photophobia, and amblyopia were not present. No information was available regarding color vision of his parents and the other members of his family.

On May 3, 1957, he received a nonpenetrating trauma on the right temporal region of the head and was sent to the Iwate Medical College Hospital. The roentgenographic examination showed a depressed fracture of the right temporal bone, combined with two linear fractures, the one extending to the cribriform plate and the other to the left optic canal across the sphenoid bone. A complete loss of sight of the left eye occurred immediately after the injury, while the sight of the right eye remained intact. Hereafter in this paper the left eye of the subject is called the affected eye, while the right eye is called the intact eye.

The Table shows the ophthalmic symptoms of the two eyes observed on the 66th day after the injury. As can be seen in the Table, the intact eye, having the normal

*Ophthalmic Symptoms of Subject's Eyes*

| | | Right Eye | Left Eye |
|---|---|---|---|
| Visual acuity | | 1.0 | 0 |
| Lid | | Blepharoptosis | Normal |
| Gaze | | Exotropia | Normal |
| Movement of eyeball | | Abduction only | Normal |
| Pupil | Form | Round | Round |
| | Light reaction | Direct l. r. fails | Direct l. r. fails |
| | | Indirect l. r. fails | Indirect l. r. is normal |
| | Lid reaction | Fails | Normal |
| Fundus | | Normal | Marked pallor in optic disc |
| Diagnosis | | Congenital total color-weakness and paralysis of oculomotor nerve | Total section of optic nerve |

Submitted for publication Feb. 6, 1959.

The Department of Physiology, Iwate Medical College; Director, Prof. T. Mita, M.D.

visual acuity, showed an absence of the direct light reflex, a loss of the consensual pupillary reaction, an exotropia and blepharoptosis, while in the affected eye the consensual pupillary reaction was normal and neither exotropia nor blepharoptosis was found. The pupils of both eyes showed the same round shape, but their size was not identical. The diameter of the right pupil was always larger than that of the left, regardless of ambient illumination. In the fundus examination of the two eyes, the retinal vessels, maculae, and fundus periphery were normal, except that pallor of the left optic disc was observed.

The results obtained from a series of psychophysical tests were as follows:

*(a) Ishihara's Pseudoisochromatic Plate Test.*—The subject was capable of identifying correctly the first plate only but not the other plates. By this identification he was suspected to be totally color-blind or totally color-weak.

*(b) Tokyo Medical College Color Vision Test.*[4]—The test plates consist of three sets of screening, qualitative, and quantitative diagnostic plates. The subject was only capable of identifying the screening Plate II-1 (a diagnostic plate for tritanopia, and this only with difficulty) and could not read any other plates. From this test, the subject seemed not to be totally color-blind, but totally color-weak.

*(c) Anomaloscope Test.*—A Nagel anomaloscope made by Takata Co. was used for a detailed examination of the color defect of this subject. The so-called Rayleigh equation was determined by matching a bipartite field, half of which was filled with a variable mixture of monochromatic red (638 mμ) and green (542 mμ) *and* the other half with yellow (589 mμ). The Rayleigh equation showed that the subject belonged to the type of deuteranope.

*(d) Dark-Adaptation Curve.*—Measurements of the photothreshold of the eye were made with a Nagel's adaptometer, after 10 minutes' exposure of the eye to a light screen (adapting light); the illuminance at the surface of the screen was about 18,000 lux. The size of a circular test patch of the adaptometer was 10 degrees in diameter. The dark-adaptation curves, which were obtained from both the intact eye and the normal trichromat's eye are shown in Figure 1. Figure 1 shows that the dark-adaptations curve of the normal trichromat's eye (called healthy eye hereafter) has two limbs, separated by a break at about seven minutes, while the photic threshold of the intact eye is about 1.5 log units higher than that of the former; besides, the break on the curve for the intact eye appeared three minutes later than in the case of the normal trichromat.

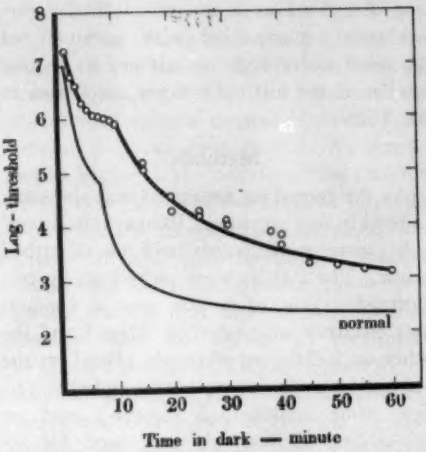



Fig. 1.—Dark-adaptation curves of the congenital totally color-weak subject (white circle) and of the normal trichromat (narrow line). Relative Unit 8 in ordinate corresponds approximately to $10^{-1}$ millilamberts.

*(e) Blocking of α-Rhythmus.*—Presenting a light stimulus to the intact eye of the subject, the blocking of α-rhythmus in EEG could be observed clearly. When the light stimulus was presented to the affected eye, the blocking of α-rhythmus did not occur, however strong the light stimulus might be. This fact confirmed objectively that the left optic nerve of the subject was ruptured completely.

On the basis of the above-mentioned examinations, the right eye of the subject

was diagnosed as a congenital total color-weakness accompanied with paralysis of the third nerve and the left eye as a total section of the left optic nerve, as shown in the Table.

## Methods

As the recording apparatus was the same as used in our previous ERG experiments,[5,6] only some main points will be described below. The ERG's were picked up by two electrodes, one of which was a contact-lens electrode originated by Riggs [7] and the other an indifferent electrode placed on the subject's temple. A capacity-coupled amplifier (time constant=2 seconds) and an ink-writing oscillograph were used for recording the ERG's. Two kinds of light sources were used. In the first case, when recording the scotopic ERG, an incandescent tungsten filament (100 volts 500 watts) was used as light source and the intensity of the light stimulus was varied, with use of a set of neutral tint filters, within a wide range covering from 0.1 to 210 lux (measured at the corneal surface of the subject's eye). Duration of the light stimulus was controlled with a photographic shutter, and it was fixed usually at 0.040 second. In the second case, when a strong light stimulus was required for recording the photopic ERG, a gas-discharge lamp (for photographic use, Kako S2) was used. Duration and luminous energy of the gas-discharge lamp were 0.66 millisecond and about $2\times10^3$ lumen-second, respectively. The line of vision was fixed centrally by a small fixation point of red light.

In the case of studying the influence of the stimulus intensity on the scotopic ERG, the experiments were commenced after a stay in darkness for 50 minutes. Three trials of light stimulation were made successively at intervals of one minute, and then five-minute intermissions were taken after every three trials. The data from the three successive trials were averaged.

The effect of dark adaptation on ERG was pursued in the course of dark adaptation which followed after the 10-minute preadaptation mentioned above. In the case of recording the photopic ERG, the eye examined was light-adapted by looking at a matted white screen illuminated by a slide projector. The field size of the adapting light was 60 degrees in visual angle, and its luminance was variable within a wide range.

## Results

*I. ERG of the Dark-Adapted Eyes.*—Comparative studies were made among three ERG's of the subject's two eyes and the healthy eye. Figure 2 shows six examples of these ERG's which were obtained with two stimulus intensities of 10 and 100 lux. As shown in Figure 2, the ERG (*A*) of the healthy eye elicited by the light stimulus of 100 lux consists of an initial negative *a*-wave, followed by a positive *b*-wave, while the ERG elicited by the stimulus of 10 lux has only a single *b*-wave without an *a*-wave. On the other hand, the ERG (*B*) obtained from the affected eye shows almost the same shape as that (*A*) from the healthy eye, while the ERG (*C*) obtained from the in-

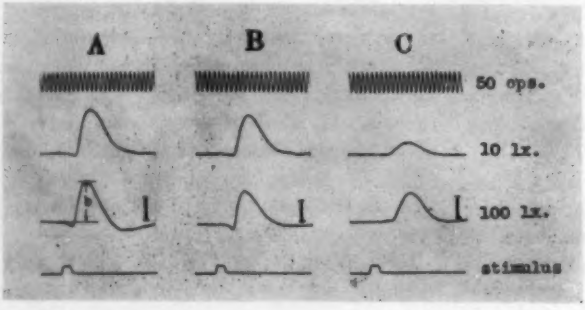



Fig. 2.—Examples of ERG's obtained from the healthy eye (*A*), the affected eye (*B*), and the intact eye (*C*), with use of white light stimuli of 10 and 100 lux in intensity. Uppermost time-mark: 50 cps; calibration: 200μV. Note that ERG's in *A* and *B* are similar in shape and size to each other, while ERG's in *C* are smaller than those in *A* and *B*, and they lack *a*-wave.

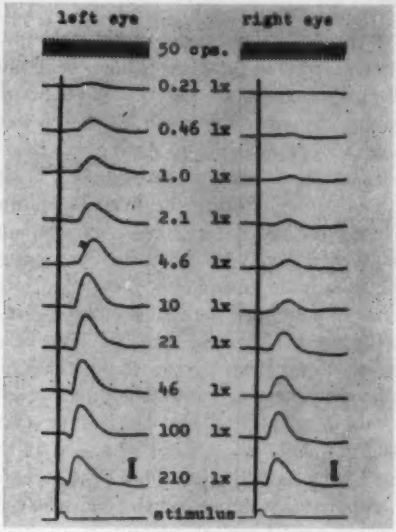



Fig. 3.—ERG's (*a*- and *b*-wave) of the dark-adapted eyes elicited by white light stimuli of various intensities. Subject: congenital total color-weakness. The left eye is affected with total section of the left optic nerve. The right eye is intact. Uppermost time-mark: 50 cps; calibration: 200μV.

tact eye differs from the former (*A*) in its shape and amplitude, that is, the ERG (*C*) lacks *a*-wave, whereas the *b*-wave on the ERG (*C*) shows a smaller amplitude than those of (*A*) and (*B*). Thus, there are found some differences between both ERG's of the affected eye and the intact eye. In this respect, the detailed examinations of ERG were attempted as follows.

1. The Relationship Between the Amplitude of the Waves and the Stimulus Intensity: A series of the various original records obtained from both eyes of the subject with various intensities of the light stimulus is shown in Figure 3. As can be seen in Figure 3, the *b*-wave of the affected eye appears clearly at the stimulus intensity of 0.21 lux and its amplitude increases with increase in light intensity until it reaches a maximum at 21 lux, whereas the *a*-wave appears for the first time at this stimulus intensity. But the *b*-wave of the intact eye appears first at 1.0 lux and grows to the maximum amplitude at 100 lux, whereas the *a*-wave can be seen first at 210 lux.

Under the same experimental conditions as stated above, the ERG's from the healthy eye of the normal trichromat were taken for comparison with those from the subject's eyes. Measurements of the amplitudes of *a*- and *b*-waves were made with all the ERG's obtained, and the data were plotted as ordinates against log-stimulus intensity as abscissae in Figure 4. As shown in Figure 4, all the amplitude log-stimulus-intensity curves for *b*-wave are S-shaped. Each of these curves has a maximum at a certain intensity of the light stimulus. The curve for the affected eye runs parallel to that for the healthy eye, although the curve for the former eye lies always somewhat lower than that for the latter one. The light intensities corresponding to the maxima

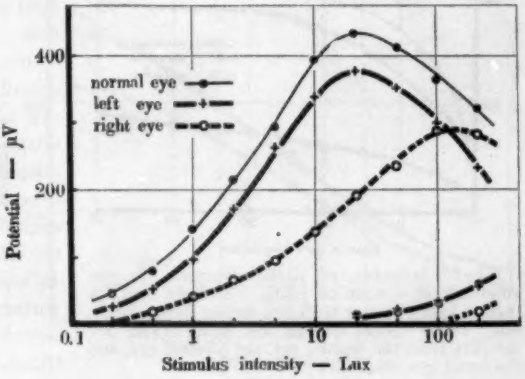



Fig. 4.—Relation between the amplitude of *a*- and *b*-wave *and* the stimulus intensity. All data were obtained from dark-adapted eyes. Ordinate: Amplitude of *a*- and *b*-wave in μV. Abscissa: log-stimulus intensity in lux. Black circles, crosses, and white circles are the data from the healthy eye, the affected eye, and the intact eye, respectively. All data are the average of from 6 to 10 measurements. Three curves in right lower corner, two of which (for crosses and black circles) overlap each other, show the relations for *a*-wave.

on the two curves are identically 21 lux, indicating approximately the same value as in the reports by Karpe and Tansley[8] (1948) and Sato[9] (1957). On the other hand, the maximum on the curve for the intact eye is reached at 100 lux; this is a higher intensity than that for the affected eye (or for the healthy eye). Furthermore, the maxima of these latter curves are different in height, namely, the maximum amplitude of the *b*-wave obtained from the healthy eye (or the affected eye) amounts to about 400$\mu$V, while that from the intact eye is smaller than 300$\mu$V.

It is worth noticing that as to the amplitude-stimulus-intensity curve for the *b*-wave, the affected eye is almost identical in character with the healthy eye, while the intact eye is very different in character from the healthy eye.

As to the *a*-wave, a remarkable difference between the two eyes is found in the same manner as in the case of the *b*-wave. That is to say, as indicated in Figure 4, the amplitude-stimulus-intensity curve of the *a*-wave for the affected eye coincides exactly with that for the healthy eye, but the curve for the intact eye does not. The *a*-wave of the intact eye can be seen only with the highest intensity (210 lux) of the light stimulus.

2. Variation in ERG During Dark Adaptation (Amplitude-Time Curve): Figure 5 shows the variations in amplitude of ERG to a constant light stimulus (21 lux) as a function of the time from the beginning of dark adaptation. In the case of the healthy eye, the amplitude of the *b*-wave increases exponentially during an early phase of dark adaptation; namely, it increases rapidly during the first 20 minutes in the dark until it reaches a plateau and and then it levels off in about 30 minutes. The amplitude-time curve for the affected eye shows almost the same characteristics as for the healthy eye. But the *b*-wave of the intact eye has a very small amplitude in the early stage of dark adaptation, namely, the dark adaptation of the *b*-wave takes place gradually at a slower rate than in the case of the healthy eye. This slow increase in amplitude continues during the whole 50 minutes' period in dark adaptation, as shown in Figure 5. This retardation of increase in amplitude of the *b*-wave of the intact eye corresponds to the retarded decrease in light threshold during dark adaptation, as stated above (Fig. 1).

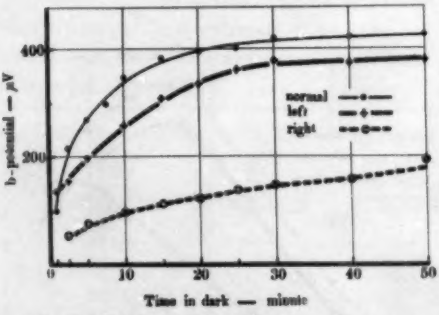



Fig. 5.—Influence of dark adaptation on the amplitude of *b*-wave of ERG. The light stimulus used is kept constant at 21 lux during dark adaptation. Black circles, crosses, and white circles are the data from the healthy eye, the affected eye, and the intact eye, respectively.

This result regarding the amplitude-time curve demonstrates that there is evidently a difference between the two ERG's obtained from both the affected eye and the intact eye, and it is likely that the scotopic retinal function of the intact eye may be inhibited by an unknown factor, while that of the affected eye is not.

*II. ERG of the Light-Adapted Eyes.*—It is well known that the *x*-wave can be recorded easily by the use of a short flash of light and a moderate degree of light adaptation. In this experiment, a flash of light of about $2\times10^3$ lumen-second was used as a stimulus and the *x*-wave was led from the eye adapted to different intensities of the adapting light. As to the effect of light adaptation on the *x*-wave, Figure 6 shows a series of the original records from both eyes of the subject. As shown in Figure 6, the ERG's show a larger negative deflection, followed by a sharp positive one. The former is the *a*-wave, and the latter is the so-called *x*-wave. In each of these records, there is evidently found a depressant effect

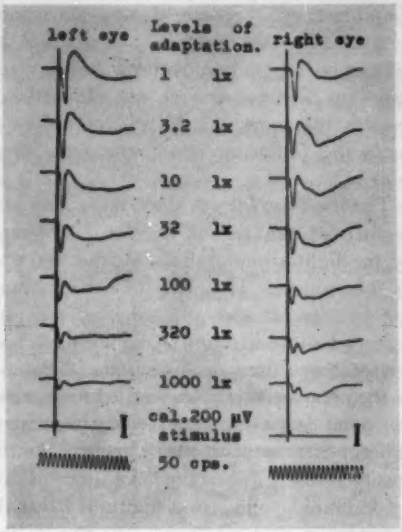



Fig. 6.—ERG's (*a*- and *x*-wave) of light-adapted eyes elicited by a fixed light stimulus (2,000 lumen second). Intensity level of the adapting light was varied from 1 to 1,000 lux. Two vertical lines indicate the onset of the light stimulus. Lowermost curve is time marking of 50 cps. Calibration for potential: 200μV. Left and right series of ERG's are the records obtained from the affected eye and the intact eye, respectively.

of the adapting light on the *x*-wave. This means the higher the level of light adaptation is, the smaller the amplitude of the *x*-wave becomes. If the amplitudes of the *x*-wave are compared between the affected eye and the intact eye under one and the same level of light adaptation, the amplitude in the former case is always larger than in the latter.

Figure 7 shows the curves plotted from the data for the amplitudes of the *x*-wave in three cases of the intact eye, the affected eye, and the healthy eye. As shown in Figure 7, the amplitude of the *x*-wave varies in an inversely proportional relation to log-intensity of the adapting light in all three cases. The amplitude-log-intensity curve for the affected eye coincides exactly with the curve for the healthy eye.

The curve for the intact eye lies always below those for the healthy eye and the affected eye. The reduction in amplitude is equivalent to a shift of ½ or ¼ unit toward the lower intensity of the adapting light.

These results demonstrate clearly that there is a definite difference of *x*-wave between both the affected eye and the intact eye and that under one and the same condition of stimulation the *x*-wave of the affected eye is always markedly larger than that of the intact eye and that ERG of the affected eye agrees fairly well with that of the healthy eye. These findings in the light-adaptation state are well in conformity with those observed in the dark-adaptation state.

## Comment

Color deficiency of the intact eye of the subject was identified to be a congenital total color-weakness, that is, a type of deuteranopia combined with tritanomalopia.

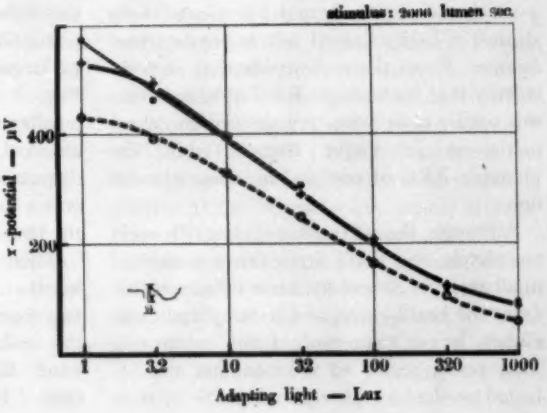



Fig. 7.—Relation between *x*-potential and logarithm of intensity of the adapting light. Black circles, crosses, and white circles are the data from the healthy eye, the affected eye, and the intact eye, respectively.

However, the ERG obtained from a subject with this type of anomalous color vision has not yet been reported, so far as I know. The ERG's obtained in this survey, therefore were compared at first with those ERG's which were reported in instances of deuteranopia, tritanopia, and achromatopsia. Armington [1] and François, Verriest, and De Rouck [10] (1956) reported that the ERG for the colored-light stimuli obtained from their subjects with deuteranopia and from those with tritanomalopia have the same aspect as those from the normal trichromat. Vukovich [3] reported that the scotopic ERG from an achromate shows a complete absence of the *x*-wave and the highly reduced *a*-wave as well as a reduction of the *b*-wave, as stated before.

The scotopic ERG obtained from the intact eye of my subject was certainly of low potential, when compared with those of the healthy eye (or the affected eye), as presented in Figures 4 and 5. This result was consistent with Vukovich's at least for the scotopic ERG, but my result for the photopic ERG was not consistent with his own, because he stated that the *x*-wave was lacking in the photopic ERG of his totally color-blind subject, whereas in my experiment the *x*-wave was found undoubtedly in the photopic state of the intact eye. In this respect, Armington,[1] Vukovich,[3] Schubert and Bornschein [11] (1952), François et al.[10] and Goodman and Bornschein [12] (1957) reported that no *x*-wave was demonstrated by colored light stimuli in both cases of achromate and protanope. From these viewpoints, it is noteworthy that the scotopic ERG obtained from this totally color-weak eye showed an achromatic or protanopic nature, while the photopic ERG of one and the same eye did not.

Although the affected eye lost its sight completely, the ERG from this eye showed in all respects almost the same nature as that from the healthy eye, and its amplitude was always larger than that of the intact eye. This result seems to indicate that the affected eye had a higher photosensitivity than the intact eye. Hence, I was confronted with an important question as to whether this difference of photosensitivity between the two eyes was genuine or not. In order to answer this question, it was necessary to settle the following two preliminary problems.

The first problem: Was there any difference of the retinal location illuminated by the light stimulus between the two eyes of the subject? If, owing to his incapacity for fixation of the affected eye, any difference had been found, it would have been one of the causes producing the difference of the photosensitivity concerned here. From this point of view, a series of supplementary experiments were made, varying the intensity, area, and retinal location of the light stimulus, and it was confirmed that the above-mentioned result, namely, the electroretinographically different sensitivity between the two eyes of the subject, was not due to different retinal location of photic stimulation between the two eyes.

The second problem: What effect on the ERG had the different sizes of pupils between the two eyes? The pupil of the intact eye dilated, showing a constant size of about 7 mm. in diameter, and it was always larger than that of the affected eye, as stated above. Then the quantity of the light stimulus which was received by the right retina must have been larger than that received by the left retina. If the two retinae were of an electroretinographically equal sensitivity to the light stimulus, the amplitude of ERG obtained from the intact eye, having a pupil of larger size, would have been larger than that of the affected eye, having a pupil of smaller size. In fact, this was not the case, as mentioned above. In view of these indisputable facts, it was concluded that there was a genuine difference of ERG's between the two eyes of the subject.

Then the second question arose as to whether this genuine difference between the two eyes was inherited or acquired after the unilateral optic nerve lesion. On one hand, Karpe,[13] (1945) showed a rule that both ERG's from two healthy eyes of a

normal trichromat are generally identical. On the other hand, Dieter [14] (1927), Trendelenburg [15] (1941), and Sloan and Wollach [16] (1948) reported that there are rare exceptions to the general rule that congenital color deficiency affects the two eyes equally. They reported some instances of subjects having normal color vision in one eye and partial or complete deficiency in the other eye and of subjects with defects in each eye differing significantly in degree. As regards this question, the present subject told me that he had never been aware of any difference in color sensation between his two eyes before receiving the unilateral optic nerve injury. His statement, of course, is important as a reference to the question, but it can not be regarded as sufficient evidence that his two eyes were affected equally. Therefore, this question can not be answered decisively. Hence, it would be natural to assume that, according to the general rule, he was a congenital color-deficient subject whose two eyes were affected equally and that the difference in sensitivity between the two eyes ensued after the injury of his left optic nerve.

Then the third question arose: Was there any relation between the atrophy of optic nerve and/or the retrograde degeneration of ganglion cells *and* the amplitude variation in ERG? According to the law of degeneration, it must be considered that such pathologic processes bring about a temporary enhancement of the retinal sensitivity. But such is not the case, as follows. According to Karpe [17] (1945), François [18] (1955), and Hirose [19] (1956), the ERG of the trichromat affected with section or atrophy of optic nerve showed invariably the same pattern as that of the normal eye. François believed that however old the optic nerve atrophy might be, the ERG remained normal in its patterns, irrespective of the degree of its atrophy and degeneration. I also confirmed the same result in another case of a normal trichromat who received a traumatic lesion of his right optic nerve.

Thus, all the works cited above differ from my result obtained from the totally color-weak subject. Therefore, this result was corroborated by repeated experiments during a long period of 33 weeks from the 66th to the 293d day after receiving the injury. These experiments demonstrated that the increase in electroretinographic sensitivity of the affected eye was always steady and not of temporary nature. In view of these facts, it is inferred that this finding may be concerned with the pathogenetic mechanism of this type of anomalous color vision.

Hence, I attempted to interpret this incomprehensible phenomenon by assuming that the optic nerve of the present subject contains some centrifugal fibers which convey the impulses having an inhibitory effect upon the retina from higher centers. If the optic nerve is ruptured, the central inhibition ceases and the increase in amplitude of ERG will ensue. At the present state of research, this assumption, of course, should be applied only to this type of color-deficient subject. Whether it applies to other types of color vision can not be decided without further research. A hypothetical explanation similar to this assumption was stated recently by Jacobson and Gestring [20] (1958), who demonstrated changes in amplitude of ERG in cat and monkey caused by a section of the optic nerve or by administration of drugs, although they found these changes immediately after the section of the optic nerve.

As to the centrifugal fibers in the optic nerve, many histological evidences have long been provided by Cajal, Dogiel, Polyak, Wolter, and others. Some electrophysiological studies on these fibers have been made by Motokawa and Ebe [21] (1954), Granit [22] (1955), and Dodt [23] (1956). Motokawa and Ebe demonstrated a depression of photosensitivity of the retina by antidromic stimulation of the optic nerve. Granit succeeded in inhibiting or facilitating the spontaneous and the evoked retinal potentials by electrical stimulation of the mesencephalic reticular substance. Dodt also was able to elicit a delayed retinal spike by shocking the optic tract of a rabbit. On the other hand, some

investigators, such as Fincham[24] (1953) and Heck and Rendahl[25] (1957), discussed the problem of whether the site of the color defect is to be found within the retina itself.

From these points of view, this survey suggests that in this type of color-deficiency there may be found a central inhibition of the retinal activity through the centrifugal fibers in the optic nerve.

## Summary

I had an opportunity to investigate the ERG in an extremely rare case of a congenital totally color-weak subject whose one eye has been affected with a complete section of the left optic nerve. The electrical responses (*a*-wave, *b*-wave, and *x*-wave) to the white light stimulus were recorded under various conditions of stimulation and comparative studies of the ERG's were made among three cases of the affected eye and the intact eye of this subject and the healthy eye of a normal trichromat.

In dark-adaptation, the amplitudes of the *a*- and *b*-waves obtained from the intact eye were definitely smaller than those from the affected eye, respectively, and the amplitude stimulus-intensity relation of the intact eye coincided approximately with Vukovich's results obtained from a totally color-blind subject, while the relation from the affected eye agreed very well with that obtained from the healthy eye which was taken as a control.

The dark-adaptation curve of the *b*-wave showed an almost identical course in the cases of the affected eye and the healthy eye, while the curve for the intact eye showed a remarkable retardation. This retardation was consistent with the result obtained from the dark-adaptation curves by a routine psychophysical test.

In light-adaptation, the relation between the amplitude of the *x*-wave and the luminance of the adapting light was similar in type for all three cases; the amplitude of the *x*-wave from the affected eye agreed well with that from the healthy eye, but the *x*-wave from the intact eye was always smaller than those from the other two eyes.

Thus it was concluded that there is a definite difference between both ERG's of the affected eye and the intact eye, and that the former eye has always an electroretinographically higher sensitivity than the latter. It was essentially unknown whether this difference had been inherited or acquired by the unilateral optic nerve section. If the latter case (acquired) is assumed, this survey suggests that the difference observed above may have a relation to the function of some centrifugal fibers in the optic nerve.

Prof. T. Mita, M.D., provided guidance and advice, and Prof. K. Imaizumi, M.D., introduced the very rare totally color-weak subject. The paper was made possible by Dr. J. E. McKeen and a scholarship from Pfizer-Taito Co. Ltd.

640 S. Kingshighway, St. Louis 10.

## REFERENCES

1. Armington, J. C.: A Component of the Human Electroretinogram Associated with Red Color Vision, J. Optic. Soc. America 42:393, 1952.

2. Motokawa, K., and Mita, T.: Über eine einfachere Untersuchungsmethode und Eigenschaften der Aktionsströme der Netzhaut des Menschen, Tohoku J. Exper. Med. 42:114, 1942.

3. Vukovich, V.: Das ERG des Achromaten, Ophthalmologica 124:354, 1952.

4. Umazume, K.: Studies on Color Sensation and Clinical Use, Jap. J. Ophth. 2:6, 1958.

5. Mita, T.; Suzuki, T., and Sato, C.: A Study on the Effects of Constant Polarizing Current on the Human Electroretinogram and Visual Sensitivity, Jap. J. Physiol., to be published.

6. Suzuki, E.; Mori, H.; Yoshino, T.; Shiwa, K., and Murase, T.: Electroretinographic Studies on Congenital Total Color-Weakness Accompanied with Optic Nerve Lesion, Acta Soc. ophth. japon. 62:962, 1958.

7. Riggs, L. A.: Continuous and Reproducible Records of the Electrical Activity of the Human Retina, Proc. Soc. Exper. Biol. & Med. 48:204, 1941.

8. Karpe, G., and Tansley, K.: The Relationship Between the Change in the Electroretinogram and the Subjective Dark-Adaptation Curve, J. Physiol. 107:272, 1948.

9. Sato, K.: Evaluation of Conditions in Recording Electrical Responses of the Human Eye, Acta Soc. ophth. japon. 61:2287, 1957.

10. François, J.; Verriest, G., and De Rouck, A.: Pathology of the X-Wave of the Human Electroretinogram, Brit. J. Ophth. 40:437, 1956.

11. Schubert, G., and Bornschein, H.: Beitrag zur Analyse des menschlichen Elektroretinogramms, Ophthalmologica 123:396, 1952.

12. Goodman, G., and Bornschein, H.: Comparative Electroretinographic Studies in Congenital Night Blindness and Total Color Blindness, A. M. A. Arch. Ophth. 58:174, 1957.

13. Karpe, G.: Basis of Clinical Electroretinography, Acta ophth., Suppl. 24, 1945, p. 63.

14. Dieter, W.: Über die subjektiven Farbenempfindungen bei angeborenen Störungen des Farbensinnes, Ztschr. Psychol. u. Physiol. Sinnesorg. 58:73, 1927.

15. Trendelenburg, W.: Über Vererbung bei einem Fall von anomalem Farbensinn des einen und normalen Farbensinn des anderen Auges beim Mann, Klin. Monatsbl. Augenh. 107:280, 1941.

16. Sloan, L. L., and Wollach, L.: A Case of Unilateral Deuteranopia, J. Optic. Soc. America 38:502, 1948.

17. Karpe, G.,[18] p. 92.

18. François, J.: Premiers essais d'électro-rétinographie clinique, Ann. ocul. 185:255, 1952.

19. Hirose, T.: Retina Electric Current of Human Being, J. Clin. Ophth. 10:505, 1956.

20. Jacobson, J. H., and Gestring, G. F.: Centrifugal Influence upon the Electroretinogram, A. M. A. Arch. Ophth. 60:295, 1958.

21. Motokawa, K., and Ebe, M.: Antidromic Stimulation of Optic Nerve and Photosensitivity of Cat Retina, J. Neurophysiol. 17:364, 1954.

22. Granit, R.: Centrifugal and Antidromic Effects on Ganglion Cells of Retina, J. Neurophysiol. 18:388, 1955.

23. Dodt, E.: Centrifugal Impulses in Rabbit's Retina, J. Neurophysiol. 19:301, 1956.

24. Fincham, E. F.: Defects of the Colour-Sense Mechanism as Indicated by the Accommodation Reflex, J. Physiol. 121:570, 1953.

25. Heck, J., and Rendahl, I.: Components of the Human Electroretinogram: An Analysis in Normal Eyes and in Colour Blindness, Acta physiol. scandinav. 39:167, 1957.

# Visual Acuity in Normal and Amblyopic Patients Under Reduced Illumination

## *II. The Visual Acuity at Various Levels of Illumination*

GUNTER K. von NOORDEN, M.D., and HERMANN M. BURIAN, M.D., Iowa City

In the first part of this study[1] we reported on the influence of a neutral-density filter on the visual acuity of patients with normal eyes, with strabismic amblyopia, and with organic retinal damage. The present, second, part deals with the visual acuity at different levels of illumination of three similar groups of patients.

Submitted for publication Feb. 9, 1959.

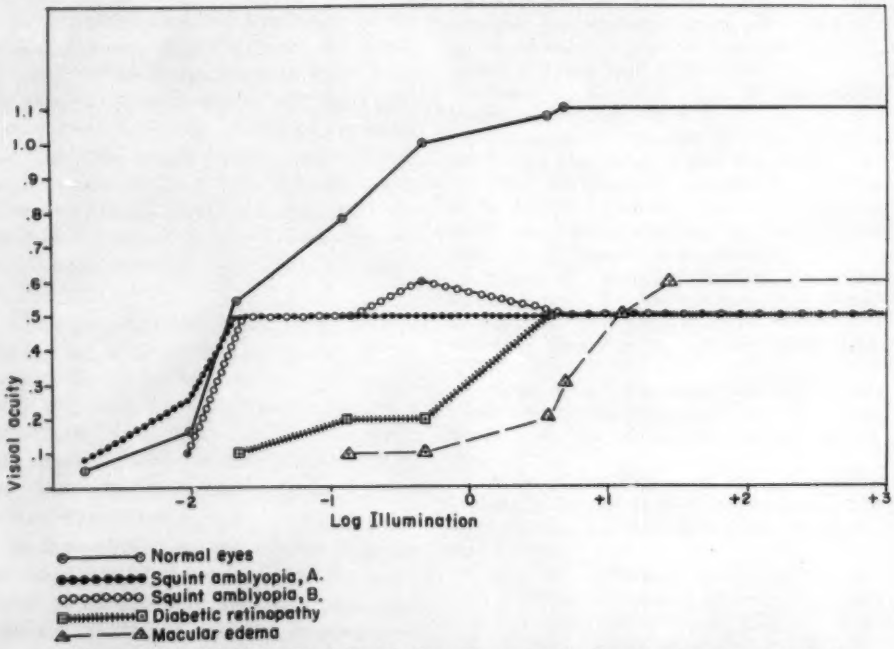
From the Department of Ophthalmology, College of Medicine, State University of Iowa.

Research supported by Grant B-349 (C5) from the National Institute of Neurologic Diseases and Blindness, National Institutes of Health, Bethesda, Md.

### Material and Procedure

Ten eyes with central fixation and strabismic amblyopia, ranging in visual acuity from 5/6 to 5/15 with single optotypes; ten eyes with amblyopia due to pathologic fundus lesions, such as diabetic retinopathy and macular edema, and ten eyes with normal visual acuity were examined.

Prior to the test the patients were kept for 10 minutes in a completely darkened room. Single optotypes (black letter "E" on white ground) were then presented at 5 meters distance. The optotypes were shown to the patients in an evenly illuminated box.




Visual acuity with 10 levels of illumination. The curve for the normal eyes represents the average of the measurements of 10 normal eyes. The curves for strabismic and organic amblyopia represent individual cases.

*Visual Acuity Values for All Observers*

| Log. Ill. | Normal Eyes | | | | | | | | | | Amblyopic Eyes | | | | | | | | | | Organic Amblyopia | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| −2.70 | 0.05 | — | — | 0.05 | 0.05 | — | — | 0.05 | 0.05 | 0.05 | — | 0.1 | — | 0.05 | 0.05 | 0.05 | — | — | — | 0.05 | 0.1 | — | — | — | — | — | 0.1 | — | — | — |
| −2.01 | 0.1 | 0.25 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.25 | 0.1 | 0.2 | 0.25 | 0.25 | 0.2 | 0.2 | 0.1 | 0.25 | 0.2 | 0.2 | 0.1 | — | — | — | — | — | 0.1 | 0.5 | 0.2 | 0.2 |
| −1.52 | 0.4 | 0.6 | 0.6 | 0.3 | 0.6 | 0.7 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.6 | 0.5 | 0.3 | 0.5 | 0.3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.2 | 0.06 | 0.25 | 0.2 | 0.06 | 0.2 | 0.1 | 0.3 | 0.3 |
| −0.86 | 0.8 | 0.8 | 0.8 | 0.6 | 1.0 | 0.8 | 0.8 | 0.8 | 0.7 | 0.8 | 0.6 | 0.5 | 0.6 | 0.5 | 0.5 | 0.6 | 0.3 | 0.5 | 0.5 | 0.5 | 0.6 | 0.5 | 0.3 | 0.5 | 0.3 | 0.06 | 0.3 | 0.2 | 0.5 | 0.5 |
| −0.34 | 1.0 | 0.9 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 1.0 | 1.0 | 1.2 | 0.6 | 0.5 | 0.6 | 0.5 | 0.5 | 0.6 | 0.3 | 0.5 | 0.5 | 0.5 | 0.6 | 0.5 | 0.5 | 0.4 | 0.5 | 0.06 | 0.7 | 0.2 | 0.5 | 0.25 |
| +0.57 | 1.2 | 1.0 | 1.0 | 1.0 | 1.0 | 1.2 | 1.0 | 1.2 | 1.0 | 1.2 | 0.5 | 0.5 | 0.6 | 0.5 | 0.5 | 1.5 | 0.3 | 0.5 | 0.5 | 0.5 | 0.6 | 0.5 | 0.1 | 0.5 | 0.5 | 0.1 | 1.0 | 0.5 | 0.6 | 0.3 |
| +0.61 | 1.2 | 1.2 | 1.0 | 1.0 | 1.0 | 1.2 | 1.0 | 1.2 | 1.0 | 1.2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 | 0.5 | 0.3 | 0.5 | 0.5 | 0.6 | 0.5 | 0.1 | 0.6 | 0.5 | 0.3 | 0.2 | 1.0 | 0.5 | 0.6 | 0.5 |
| +1.09 | 1.2 | 1.2 | 1.0 | 1.0 | 1.0 | 1.3 | 1.0 | 1.2 | 1.0 | 1.2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.3 | 0.5 | 0.5 | 0.6 | 0.5 | 0.3 | 0.6 | 0.5 | 0.3 | 0.3 | 1.0 | 0.6 | 0.6 | 0.6 |
| +1.42 | 1.2 | 1.2 | 1.0 | 1.0 | 1.0 | 1.2 | 1.0 | 1.2 | 1.0 | 1.2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.3 | 0.5 | 0.5 | 0.6 | 0.5 | 0.2 | 0.6 | 0.5 | 0.5 | 0.3 | 1.0 | 0.6 | 0.6 | 0.6 |
| +2.28 | 1.2 | 1.2 | 1.0 | 1.0 | 1.0 | 1.2 | 1.0 | 1.2 | 1.0 | 1.2 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.3 | 0.5 | 0.5 | 0.6 | 0.5 | 0.2 | 0.6 | 0.5 | 0.5 | 0.3 | 1.0 | 0.6 | 0.6 | 0.6 |

The illumination was controlled by a rheostat.

Stepwise measurements of the visual acuity were performed at 10 levels of illumination, beginning at low-threshold levels and ending with the maximum illumination at our disposal. The illumination of the background of the box in which the optotypes were presented was measured with a McBeth Illuminometer in foot-candles for the 10 rheostat settings which were employed. The values are expressed in log illumination in the Table and the Figure.

## Results

The data obtained from the normal eyes were so consistent (Table) that mean arithmetic values were derived and charted for comparison with the data from abnormal eyes (Figure).

The eyes with strabismic amblyopia showed an increase in visual acuity at the same or at an even earlier level of illumination than the normal eyes. They reached their maximum resolving power when the normal eyes had not even reached one-half of their final visual acuity. In other words, the amblyopic eyes maintained their maximum visual acuity at levels of reduced illumination at which the normal eyes showed already a marked drop in acuity. Indeed, two eyes in this group showed already an actual increase in their acuity at illuminations ranging from 0.1 to 1.1 ft-c. This finding is in agreement with the results which we obtained with use of a single neutral-density filter.

In contrast to the patients with strabismic amblyopia, the patients with organic retinal lesions showed an early and marked reduction in their acuity when the level of illumination was reduced.

All the data are summarized in the Table. In the Figure the findings in two eyes with strabismic amblyopia, in one eye with diabetic retinopathy, and in one eye with macular edema are compared with the mean curve of the normal eyes.

## Comment

The results of this study are entirely in accord with those obtained with the use of a single neutral-density filter.[1] In cases in which an amblyopia is due to an organic affection of the rods and cones or of immediately adjacent structures, there is a very considerable loss of visual efficiency with reduced illumination. Remarkably enough, such is not the case in patients with strabismic amblyopia: Here the visual acuity at low levels of illumination is equal to, or occasionally even better than, the acuity of the normal fellow eye. A difference in the behavior of the visual functions under conditions of reduced illumination in patients with organic and strabismic amblyopia had been noted already in 1884, by Bjerrum,[2] but little or no attention has been paid to this observation.

The explanation for the relatively improved or even normal function of the eyes with strabismic amblyopia at low levels of illumination is not at once obvious and must at present remain in the realm of hypothesis. So much is clear, however, that the mechanism which is operative in strabismic amblyopia must differ essentially from the one effective in the presence of organic lesions.

Strabismic amblyopia may be thought of as primarily sensory or motor in origin or as a disturbance into which both these factors enter. All our findings to date strongly support the assumption that strabismic amblyopia represents in essence a selective inhibition of form vision.[3] Strabismic amblyopia would thus be a selective inhibitory adaptation of the sensory visual system occurring in the presence of ocular anomalies outside the retina (motor in the case of strabismic amblyopia, refractive in the case of refractive amblyopia) and whose seat is likely to be in the higher pathways of the visual system. Under conditions of mesopic vision, in which the acuity function plays a minor role, an inhibition of the normally functioning system of which the cones are the initial elements, does not take place. Under these conditions the amblyopic eye does indeed closely resemble the normal eye in all its functions.

If one considers strabismic amblyopia to be essentially an abnormality of the motor system, as does, for example, Linksz,[4] one would have to postulate that an improvement in visual acuity under reduced illumination results from an improvement of the fixation pattern of the amblyopic eye in the dark. Such an improvement has been assumed and has indeed been shown to exist, for instance, by our electro-ophthalmographic investigations.[5] However, there is no direct relationship between the depth of the amblyopia and the unsteadiness of fixation (Mackensen,[6] also confirmed by us), and we have seen a number of patients with strabismic amblyopia who exhibited perfectly steady fixation in electro-ophthalmographic tests even under conditions of light adaptation. These findings make it unlikely that strabismic amblyopia is primarily a motor anomaly.

## Summary

By testing the visual acuity after 10 minutes of dark adaptation with single optotypes at 10 levels of illumination, it is shown that eyes with strabismic amblyopia perform as well or better than the normal fellow eyes. In contrast, eyes with organic amblyopia exhibit a very marked decrease in visual acuity even with relatively slight reductions in illumination. A more thorough investigation of the acuity functions of the dark adapted amblyopic eye should be undertaken, for example, by testing the vernier acuity.

Department of Ophthalmology, University Hospitals.

## REFERENCES

1. von Noorden, G. K., and Burian, H. M.: Visual Acuity in Normal and Amblyopic Patients Under Reduced Illumination: I. Behavior of Visual Acuity With and Without Neutral Density Filter, A. M. A. Arch. Ophth. 61:533-535, 1959.

2. Bjerrum, J.: Untersuchungen über den Lichtsinn und den Raumsinn bei verschiedenen

Augenkrankheiten, von Graefe's Arch. Ophth. 30:201-260, 1884.

3. Wald, G., and Burian, H. M.: The Dissociation of Form Vision and Light Perception in Strabismic Amblyopia, Am. J. Ophth. 27:950-963, 1944.

4. Linksz, A.: Physiology of the Eye, Vision, New York, Grune & Stratton, Inc., 1952, Vol. 2.

5. von Noorden, G. K., and Burian, H. M.: An Electro-Ophthalmographic Study of the Behavior of the Fixation of Amblyopic Eyes in Light- and Dark-Adapted State: A Preliminary Report, Am. J. Ophth. 46:68-77 (July, Pt. 2) 1958.

6. Mackensen, G.: Das Fixationsverhalten amblyopischer Augen, von Graefes Arch. Ophth. 159:200-211, 1957.

# The Treatment of Chronic Uveitis

*Preliminary Comments on Chronic Degenerative Diseases*

DAN M. GORDON, M.D., New York

Chronic intraocular inflammation is a devastating disease. The alternative to treatment is usually blindness.

This paper concerns itself with three groups of patients. The first includes those with chronic intraocular inflammation, mostly chronic uveitis, who have been treated for a period of six months or more. The second group comprises those with chronic inflammation who have been treated less than six months and for whom the prognosis is not always clear. The third group, which is not analyzed statistically at this time but which must be mentioned, consists of those persons who hitherto have been considered hopeless, mostly because of chronic degenerative diseases, such as macular degeneration. In this latter group the failures far outnumber the successes. However, these are failures to succeed and not failures to try.

The definition of chronic uveitis is not simple. For purposes of this paper, chronic uveitis is defined as an inflammation of the uveal tract that has persisted for more than six weeks or that has had serious recurrences. Most of the cases considered here have been easy to classify. A large number of patients with mild recurrent uveitis, usually of the anterior segment, who have readily responded to treatment have been omitted from consideration. Only one patient has been treated entirely by subconjunctival injections. In the rest we have employed combinations of oral, intramuscular, and/or intravenous, as well as additional topical and in many cases subconjunctival steroid injections.

Submitted for publication April 14, 1959.

The New York Hospital-Cornell Medical Center and the L. Margolyes League.

## Analysis of Results

This paper covers 93 patients treated for periods ranging from several months to over nine years; most for one or more years (Table 1). Eighteen of these were blind in the contralateral eye, only two owing to causes other than uveitis, and five additional cases had macular scars producing central blindness in the other eye. Hence 23 of the 93 were totally dependent upon the affected eye. In four of these one eye had been enucleated.

The intensity of the disease can be gauged by the fact that 62 of this group had been referred for the most part by other ophthalmologists, usually after a considerable period of unsuccessful treatment. I had considered attempting to classify the patients by their degree of severity but found that practically all of them would have to be considered as real therapeutic problems. Twenty-one are recorded as having had bouts of glaucoma, only two of which appeared to be primary in type. Eleven of these twenty-one had had surgery for glaucoma; only three by me. Four of this group have undergone successful surgery for bilateral cataracts. Two of the patients who had had previous operation for secondary glaucoma suffered degeneration of the surgically treated eye.

Forty-six had obvious choroidal lesions; three others had macular edema, even though no specific choroidal lesion could be discerned; one had bilateral optic neuritis of at least one year's duration, and another had noninflammatory retinal colloid degeneration associated with rheumatoid arthritis. Another patient, in whom generalized uveitis in the only seeing eye had been successfully

TABLE 1.—*Case Data*

| Case | Sex | Age | Diagnosis | Duration of Disease | Eyes Involved | Status Other Eye | Etiologic Clue | Duration of Therapy | Result | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M | 22 | Chr. uveitis; sec. glauc. | Years | 1 | Enucleated; uveitic detach. | Boeck's sarcoid | 9+ yr. | Very good control | Cushings |
| 2 | F | 39 | Gen'l uveitis; sec. glauc. | Years | 2 | -- | Endocrine | 9+ yr. | Very good control; cat. removed | Cushings |
| 3 | M | 40 | Dissem. choroiditis | Years | 1 | Central scar | -- | 9+ yr. | Excell. | -- |
| 4 | M | 41 | Gen'l uveitis; sec. glauc. | Years | 2 | -- | -- | 8+ yr. | Excell. | -- |
| 5 | F | 19 | Gen'l uveitis | Years | 2 | -- | -- | 8+ yr. | Good | -- |
| 6 | F | 64 | Colloid degen. | Years | 2 | -- | Rheum. arthritis | 8+ yr. | Excell. | Asymptomatic osteoporosis |
| 7 | F | 47 | Gen'l uveitis | 9 yr. | 1 | Endoph. | -- | 7+ yr. | Excell.; assoc. colloid degen. | Past 2 yr. little systemic |
| 8 | F | 48 | Gen'l uveitis | Years | 1 | Endoph. | -- | 6+ yr. | Very good | Cushings |
| 9 | F | 30 | Rec. juxta. | 2 yr. | 1 | Normal | -- | 11 mo. | Excell. | No rec. 2½ yr. |
| 10 | F | 67 | Juxta. | Recent | 1 | Normal | -- | 11 mo. | Excell. | No rec. 2+ yr. |
| 11 | F | 52 | Rec. choroiditis | Recent | 1 | Normal | -- | 6 yr. intermittent | Excell. | No rec. 2½ yr. |
| 12 | M | 30 | Gen'l uveitis | 6+ mo. | 1 | Normal | -- | 6¾ yr. | Excell. | Off therapy 2 yr. |
| 13 | F | 10 | Rec. choroiditis | Months | 1 | Normal | -- | 5½ yr. | Excell. | -- |
| 14 | F | 33 | Gen'l uveitis; sec. glauc. | 10 yr. | 1 | Endoph. | Endocrine | 6+ yr. | Excell. | Water retention |
| 15 | M | 37 | ? Inactive post. uveitis | 15 yr. | 2 | -- | -- | 5½ yr. | 20/200 imp. to 20/70 | Developed intolerance to systemic steroids; jittery |
| 16 | M | 27 | Ant. uveitis | Recent | 2 | -- | Rheum. arthritis; gastrointestinal ulcers | 5+ yr. | Very good | -- |
| 17 | M | 27 | Mac. choroid. | Old | 1 | Normal | -- | 4½ yr. | Very good | Can usually control with subconj. |
| 18 | F | 31 | Rec. choroid. | 11 yr. | 1 | Normal | -- | 2 yr. | Excell. | -- |
| 19 | M | 58 | Rec. juxta & opt. neuritis | -- | 2 | -- | -- | 1+ yr. | Very good | Off therapy 6 yr. |
| 20 | F | 38 | Rec. uveitis | 2 yr. | 1 | Normal | -- | 4 mo. | Excell. | -- |
| 21 | M | 27 | Behcet's | 6 mo. | 2 | -- | E. nodosum | 2+ yr. | Control 1+ yr., then lost | Rebound permitted |
| 22 | M | 31 | ? Central serous | 3 wk. | 1 | Normal | -- | 8 mo. | Excell. | Off therapy 3+ yr. |
| 23 | M | 39 | ? Phakogen. prim. glauc. | Years | 1 | Blind | Toxo. Brucel. | 5½ yr. | Poor control | -- |
| 24 | F | 67 | Chr. uveitis; sec. glauc. | 2 yr. | 1 | Malig. mel.; enuc. | -- | 5 yr. | Excell. | -- |
| 25 | M | 41 | ? Central serous | Recent | 1 | Normal | -- | 5 mo. | Mod. imp. | -- |
| 26 | M | 48 | Rec. choroid.; vit. hem. | 5 yr. | 1 | Normal | -- | 11 mo. | Excell. | No therapy 2 yr. |
| 27 | M | 55 | Rec. ant. uveitis | 5 mo. | 1 | Normal | -- | 2 yr. | Very good | -- |
| 28 | M | 24 | Mac. choroid. | 3 wk. | 1 | Normal | -- | 5 mo. | Excell. healing but central scar | Therapy had been delayed pending survey |
| 29 | M | 56 | Severe rec. choroid. | 6 mo. | 1 | Normal | -- | 1+ yr. | At first control., then lost | -- |
| 30 | M | 23 | Mac. choroid. | 2 yr. | 2 | -- | -- | 2 yr. | Very good | Bizarre macular disease; excell. vision with deep (?) scars |

TABLE 1.—*Case Data*—Continued

| Case | Sex | Age | Diagnosis | Duration of Disease | Eyes Involved | Status Other Eye | Etiologic Clue | Duration of Therapy | Result | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| 31 | F | 22 | Disloc. lens; uveitis; glauc. | 5+ yr. | 1 | Blind, same cause | Disloc. lens | 1½ yr. | Fair control | Not controlled by therapy but by surgery |
| 32 | F | 37 | Rec. juxta. | 2 yr. | 1 | Normal | Rheum. arthritis 18 yr. | 1 yr. | Excell. | -- |
| 33 | F | 42 | Choroid. | 1+ yr. | 1 | Blind, uveitic detach. | -- | 15 mo. | Excell. | Inactive 1 yr. |
| 34 | F | 37 | Uveitis; prim. glauc. | 2+ yr. | 1 | Blind, uveitic detach. | -- | 2+ yr. | Excell. | Inactive 3 mo. |
| 35 | F | 57 | Rec. uveitis | Years | 2 | -- | -- | 2 yr. | Excell. | Occas. remissions |
| 36 | F | 38 | Rec. choroid. | 6+ yr. | 1 | Normal | -- | 1 yr. | Excell. | Long remissions |
| 37 | F | 50 | Aphakia; uveitis; sec. glauc. | 6 mo. | 1 | Blind, same cause | -- | 8 mo. | Excell. | -- |
| 38 | F | 34 | Atypical choroidal disease | Years | 1 | Blind, same cause | -- | 4 mo. | None, equivocal | Noninflammatory disease, not classified |
| 39 | F | 60 | ? Inactive uveitis | Years | 2 | -- | -- | 10 mo. | Imp. 6/200 to 8/80 | Cannot tolerate adequate doses, gastrointestinal symptoms |
| 40 | M | 53 | Rec. mac. choroid. | 1 yr. | 1 | Normal | -- | 6 mo. | Excell. | -- |
| 41 | M | 68 | Choroid.; sec. glauc. | Years | 2 | -- | -- | 2 yr. | Excell. | Osteoporosis, off systemic 1+ yr. |
| 42 | F | 29 | Gen'l uveitis | Years | 2 | -- | Multiple sclerosis | 7+ yr. | Excell. | No severe m. s. symptoms |
| 43 | F | 45 | Gen'l uveitis rec. | Recent | 2 | -- | Brain tumor | 2½ yr. | Excell. | -- |
| 44 | F | 55 | Rec. ant. uveitis; sec. glauc. | Recent | 2 | -- | Diabetes | 3 yr. | Excell. | -- |
| 45 | F | 58 | Ant. uveitis; glauc. | Recent | 1 | Normal | -- | 1 yr. | Very good | Off systemic 6 mo. |
| 46 | M | 34 | Acute choroid. | Recent | 1 | Normal | -- | 3 mo. | Control, then lost | Rebound permitted |
| 47 | F | 49 | Choroid. | ? | 1 | Normal | -- | 3 mo. | Sudden collapse of eye | -- |
| 48 | F | 34 | Choroid. rec. | Years | 1 | Normal | -- | 1+ yr. | Very good | Patient not too cooperative |
| 49 | F | 36 | Mac. choroid. | Years | 1 | Mac. scar | Toxo. | 1+ yr. | Excell. | Severe bleeding on Toxo. therapy |
| 50 | M | 60 | ? Inactive choroid. | 33 yr. | 1 | Blind, same cause | -- | 4 yr. | Imp. 8/200 to 20/70 | Developed gastrointestinal symptoms |
| 51 | M | 43 | Gen'l uveitis | 2½ yr. | 1 | Blind, uveitic detach. | -- | 4½ yr. | Excell. | -- |
| 52 | M | 32 | Choroid. | 2 yr. | 1 | Enuc., same cause | ? TB | 3½ yr. | Excell. | Water retention, bloating |
| 53 | M | 62 | Gen'l uveitis; sec. glauc. | 2 yr. | 2 | -- | -- | 4½ yr. | Excell. | Inactive 14 mo. |
| 54 | M | 30 | Uveitis | Recent | 1 | Normal | -- | 6 mo. | Excell. | No recurrence |
| 55 | M | 68 | ? Inactive choroid. | 4 yr. | 2 | -- | -- | 5+ yr. | Equivocal | -- |
| 56 | F | 12 | Uveitis | 5 yr. | 1 | Normal | -- | 3+ mo. | Improving | -- |
| 57 | M | 42 | Perivasculitis | 5 mo. | 1 | Mac. scar | Toxo. | 2½ mo. | Excell. | Cushings |
| 58 | F | 22 | Mac. choroid. | 5 mo. | 1 | Mac. scar | Toxo. | 1 mo. | Excell. | Unable to tolerate Toxo. therapy |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 59 | M | 52 | Choroid.; mac. hems. | Months | 1 | Mac. scar | ? TB | 6 mo. | Imp. 5/200 to 25/60 | Sod. heparin 2 mo. helped |
| 60 | F | 65 | Aphakia; mac. disease | Months | 1 | Normal | -- | 6 mo. | Imp. <20/200 to 20/60 | Diagnosis unclear, not inflammatory |
| 61 | M | 49 | Chr. optic neuritis | 1 yr. | 2 | -- | -- | 6+ mo. | Very good | Water retention |
| 62 | F | 60 | Rec. choroid.; sec. glauc. | -- | 1 | Normal | Diabetes | 6 mo. | At first excell., now equivocal | Ill, infirm, difficult to manage |
| 63 | M | 52 | Perivasculitis | 1 mo. | 1 | Normal | -- | 5 mo. | Excell. | -- |
| 64 | F | 22 | Rec. uveitis | Years | 2 | -- | -- | Intermittent | Equivocal | Uncooperative |
| 65 | F | 71 | Choroid. | 6 mo. | 1 | Normal | -- | 1½ yr. | Excell. | Water retention, off therapy 3 mo. |
| 66 | F | 26 | Gen'l uveitis | 8-9 yr. | 1 | Normal | -- | 9 mo. | Imp. 20/80 to 25/50 | -- |
| 67 | F | 51 | Gen'l uveitis | Years | 1 | Normal | Rheum. arthritis | 9 mo. | Sl. imp. | Mkd. improvement in ambulation & well-being; water retention; petechiae |
| 68 | F | 40 | Gen'l uveitis | 3 yr. | 1 | Normal | -- | 6 mo. | Imp. 5/200 to 20/100 | -- |
| 69 | M | 40 | Choroid. | Months | 1 | Normal | Diabetes | 6 mo. | Unimp. | Became temporarily psychotic |
| 70 | F | 33 | Juxta. rec. | 2 yr. | 1 | Normal | -- | 6 mo. | Excell. | -- |
| 71 | F | 47 | Rec. juxta. | 1 yr. | 1 | Normal | Calcified hilar nodes | 6 mo. | Excell. | -- |
| 72 | M | 36 | Choroid. | Months | 1 | Normal | -- | 6 mo. | First imp., then lost | Rebound, no recovery |
| 73 | M | 15 | Sympathetic | Months | 1 | Normal | -- | 5 yr. | Excell. | -- |
| 74 | F | 6 | Uveitis | 1 yr. | 2 | -- | -- | 6 mo. | Improving | -- |
| 75 | M | 55 | Gen'l uveitis | Years | 1 | Blind, uveitic detach. | -- | 5+ yr. | Excell. | Cushings; recent traumatic fracture; excell. callus; no osteoporosis |
| 76 | M | 31 | Gen'l uveitis | 3 yr. | 1 | Normal | E. nodosum | 5+ yr. | Control 4+ yr., then lost | Water retention |
| 77 | F | 30 | Mac. choroid. | 2 yr. | 1 | Normal | Diabetes | 4+ yr. | Good healing | Off therapy 1 yr. |
| 78 | M | 35 | Rec. choroid. | Years | 1 | Normal | Toxo. | 3½ yr. | Excell. | -- |
| 79 | F | 8 | Gen'l uveitis | ? | 2 | -- | -- | 3 yr. | 1 Eye excell., other fair | Zonular dyst. & cat. prior to therapy, will not or cannot tolerate systemic therapy |
| 80 | F | 66 | Phakogenic | Months | 1 | Blind | ? Phakogenic | 7+ yr. | Excell. | Mostly topical therapy since lens extraction |
| 81 | F | 34 | Rec. choroid. | Recent | 1 | Normal | -- | 5 mo. | Excell. | -- |
| 82 | M | 42 | Gen'l uveitis; rec. sec. glauc. | ? | 1 | Blind, same cause | Flared up on cyclodiathermy | 1 yr. | Excell. | -- |
| 83 | M | 36 | Mac. choroid | Recent | 1 | Normal | -- | 1 yr. intermittent | Excell. | No recurrence 8 yr. |
| 84 | M | 34 | Choroid. rec. | Years | 1 | Normal | -- | 1 yr. | Excell. | -- |
| 85 | F | 34 | Rec. uveitis | -- | 1 | Normal | -- | 3 mo. | Excell. | Therapy continues |
| 86 | F | 34 | Gen'l uveitis | Years | 2 | -- | -- | 8+ yr. | Good | -- |
| 87 | F | 49 | Uveitis; sec. glauc. | 2 yr. | 2 | -- | Boeck's sarcoid | 4 yr. | Excell. | -- |
| 88 | M | 30 | Central choroid | Recent | 1 | Normal | -- | 1 yr. | Excell. | -- |
| 89 | M | 32 | Choroid | 2 mo. | 1 | Normal | -- | 1+ yr. | Excell. | Mostly subconjunc. therapy |
| 90 | M | 52 | Central choroid | 3 wk. | 1 | Normal | -- | 1½ yr. | Very good | Bizarre type lesion; residual retinal cyst |

TABLE 1.—*Case Data*—Continued

| Case | Sex | Age | Diagnosis | Duration of Disease | Eyes Involved | Status Other Eye | Etiologic Clue | Duration of Therapy | Result | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| 91 | M | 50 | ? Central serous prim. glauc. | 3 wk. | 1 | Prim. glauc. | Emotional tension | 6 mo. | Equivocal, although imp. | :: |
| 92 | F | 51 | Mac. chorold. | 6 mo. | 1 | Enuc., old glauc. | Healed pulm. TB | 3½ mo. | Excell. healing | :: |
| 93 | M | 52 | Sympathetic | Recent | 2 | :: | Surgery | 1+ yr. | Excell. 20/15 | :: |

controlled, ultimately developed central colloid degeneration which markedly affected her vision. She has been seen by a number of excellent ophthalmologists here and abroad, all of whom concur in the belief that the uveitis did not cause the colloid degeneration. Because the uveitis has been well controlled, this patient is considered a "success."

Four were under 15 years of age when first seen, while another teen-ager was treated successfully for sympathetic ophthalmia. None of the youngsters have arthritis, and only one has a band-shaped corneal dystrophy.

No attempt is made here to evaluate statistically the etiology of the diseases. Those clues considered important in the etiology have been recorded in Table 1. This does not imply that these are the true causes. In many cases, such as that of one woman (Case 92) with healed pulmonary tuberculosis occurring 10 years before, the "clue" is probably not the etiological factor. The clues to etiology were Boeck's sarcoid, two; endocrine disturbances, two; rheumatoid arthritis, four; erythema nodosum, two; Behcet's syndrome, one; toxoplasmosis, five (two of these had a positive skin test for brucellosis); tuberculosis, four; diabetes, four; phakogenic, one; multiple sclerosis, one, and sympathetic ophthalmia, two. One of the women (Case 2) classified as "endocrine" was symptom-free during her pregnancies and has exacerbations associated with her menses. The second woman so classified (Case 14) has never had ovarian function. When her menses were artificially induced, she suffered a severe exacerbation of her uveitis.

Only 17 patients, including both of those with sympathetic ophthalmia, exhibited a biological cure in the sense that the disease ultimately burnt out. One of these, Case 53, who had been off systemic steroid therapy for approximately one year, was seen after Table 1 was compiled and while this paper was being written with a recurrence of his uveitis and secondary glaucoma. This was

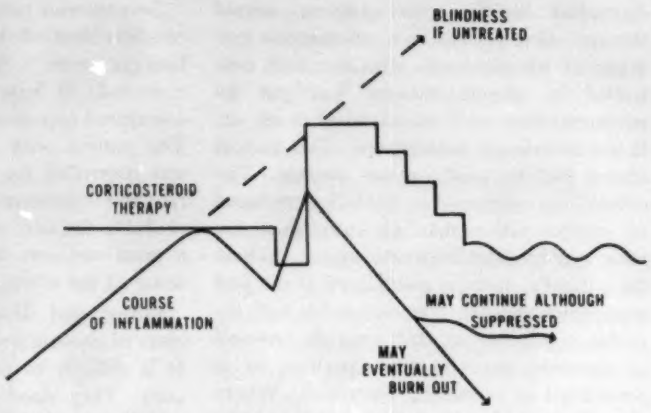
controlled rapidly with systemic steroid therapy. One patient with presumptive evidence of toxoplasmosis who was well controlled by steroid therapy was put on pyrimethamine and sulfadiazine in an attempt to prevent recurrences. This patient almost bled to death on this therapy. The criteria for evaluation in Table 1 were based on control rather than on cure, since the latter is infrequent in chronic uveitis. Where the patient's status is maintained at the best level which appears to be compatible with his ocular condition, as, for example, corneal or choroidal scars or lens opacities, he is considered as excellently controlled. Where the status is just under that, he is considered as very good, though still a success. Where the status has not been especially improved, he is considered as "equivocal." In some of the latter, actual improvement occurred, but it did not appear to me that it was attributable to the therapy and hence these patients were rated as equivocal. Where there was appreciable loss of ocular function or spread of the disease during a period of adequate therapy, the patient was considered as a "failure." Patients who did not permit a fair trial of treatment were not included nor were those upon whom there was inadequate follow-up. A large group of clinic patients whom I saw infrequently and for whose complete treatment I was not responsible are not included in this series regardless of their results. Most of this group (Table 1) consist of patients who are part of my private practice. A large number of other patients have been seen infrequently in consultation with their ophthalmologists, but since I was not responsible for their complete therapy, they have not been included. One of these, for example, is an aged person with sympathetic ophthalmia who, in the mind of his internist, has a condition which contraindicates systemic therapy. This patient has never been seen by me but has been treated by me over the telephone in collaboration with his ophthalmologist in a distant city and has responded very successfully. There are many others in a similar category.

Seventy-nine patients are regarded as successfully controlled or as having achieved a biologic cure. Six are considered as equivocal; at least two of these could be considered as improved. Eight were failures. The patient with Behçet's syndrome who was controlled for well over a year until a rebound phenomenon was permitted is probably the first in the literature to exhibit a good response to therapy, probably because of the adequacy of the dose.

Offret and Haye[1] have reported 110 cases of chronic uveitis treated with steroids. It is difficult to compare their series with ours. They cited the etiology in approximately two-thirds of their cases, an inordinately high figure. Sixteen of their cases were of sympathetic ophthalmia and twelve of post-traumatic uveitis. I have not included post-traumatic uveitis, as I do not feel that this can be classified properly as "chronic uveitis." They stressed the use of concomitant antimicrobial therapy to prevent infections, an unnecessary precaution. They also stressed the paucity of biologic cures and the need for maintenance therapy. In view of the fact that the alternative in a true chronic uveitis is usually blindness, long-term therapy should not be considered as a deterrent to treatment.

## Management

The plan of therapy is that depicted in the Figure. Given a patient with a chronic intraocular inflammation, there is always the very remote possibility that he may recover spontaneously. However, one should not rely upon this fortuitous event. If the patient is untreated, the eye will probably become blind. This paper stresses the long-term use of systemic steroid therapy, employing corticotropin (ACTH), cortisone, hydrocortisone, and their synthetic derivatives, namely, prednisone, prednisolone, methylprednisolone, triamcinolone, and, more recently, dexamethasone. A number of experimental preparations which have never attained commercial recognition have also been employed. Corticosteroid therapy is




Management of chronic intraocular inflammation. On the left the course of the disease begins. If untreated (broken line), blindness will probably ensue. If treated (curved line) with adequate doses, the disease will usually respond. If the dose (steps) is dropped too precipitously, an exacerbation (ascending line) will occur. The dose is now increased to a point above that at time of exacerbation. As the disease responds, the dose is now slowly decreased by step-like decrements until the disease either burns out or must be constantly suppressed by the minimum possible maintenance dose. The maintenance dose, as determined by trial and error, is that amount which will just suppress the signs and symptoms of the disease.

not a substitute for specific therapy when one can pinpoint the etiology with some degree of certainty and has specific therapy available. However, both of these eventualities occur but rarely. The simultaneous use of systemic steroid therapy and specific therapy has much to recommend it.

When one is combating a severe intraocular inflammation, he should think in terms of so many milligrams of drug against so many milligrams of disease. Since it is impossible to gauge the severity of the disease, therapy should be initiated at a high dosage level of approximately 120 to 160 units of repository corticotropin injection (corticotropin gel or zinc) or 25 units of corticotropin in 1,000 cc. of saline solution given as an intravenous drip running for a minimum of 12 to 16 hours, or 8 to 12 tablets of one of the commercially available oral steroids which have been enumerated, or their equivalents. As depicted on the left side of the Figure, therapy is continued at a high level until the disease has made an obvious response. At this point the dose can gradually be tapered down in decrements of 10 units of intramuscular corticotropin or one tablet of the steroid approximately every several weeks, providing there is no relapse. Relapse is a signal for an increase of at least two increments of therapy until the disease has again been

TABLE 2.—*Initial Systemic Doses in Chronic Disease*

| | Dose, Mg. |
|---|---|
| Corticotropin | |
| Intramuscular | 80-120 units |
| Intravenous | 25 units in 1,000 cc. saline |
| Cortisone * | 300 |
| Hydrocortisone * | 200 |
| Prednisone | 40-60 |
| Prednisolone | 40-60 |
| Methylprednisolone | 32-40 |
| Triamcinolone | 32-40 |
| Dexamethasone | 4.0-6.0 |

* Have been replaced by the newer preparations which give fewer side-effects.

TABLE 3.—*Management of Complications*

| Complication | Management |
|---|---|
| Synechiae (often melt under therapy) | Mydriatics |
| Myopia | Refract |
| Secondary glaucoma | Treat uveitis + carbonic anhydrase inhibitors to break cycle; surgery rarely necessary |
| Cataracts | Systemic therapy before, during, & after surgery |
| Detachments | Control inflammation; surgery should be deferred until inflammation subsides |
| Vitreous membranes | Long-term systemic therapy |
| Band-shaped keratitis | Chelation with edathamil sodium, 2% HCl |
| Optic neuritis | Systemic therapy, preferably intravenous corticotropin |
| Phthisis | Therapy useless |

brought under control. Once the disease is again suppressed, the tapering process is resumed. In chronic uveitis the probabilities of a biologic cure, that is, burning out of the pathogenic mechanism, are poor. One must anticipate treating for months to years in the hope that one of three eventualities will occur: 1. The disease process will burn out permitting discontinuance of therapy. 2. A specific therapy will be discovered. 3. A more dramatic therapy than we are now employing will be found.

Today one must treat with steroid therapy, specific therapy if available, or a combination of the two in an attempt to maintain the integrity of the globe until something better comes along, if the disease does not burn out. One arrives at the minimum necessary maintenance dose which will preserve the eye as a useful organ of vision by the process of trial and error indicated in the Figure. Since we are rarely able to pinpoint the etiology of intraocular inflammation, steroid therapy remains as the only hope for the bulk of these patients.

The dose must always be reconciled with the patient's physical safety. Fortunately most can tolerate large doses for long periods with no severe side-effects. Where untoward effects do appear, good medical management may enable the patient to take the necessary maintenance dose. If this proves impossible, the dose must be decreased to that amount compatible with the patient's well-being, even though some ocular symptoms recur. The concomitant use of subconjunctival (sub-Tenon's) injections of steroids will often bridge the gap. In some patients subconjunctivally deposited steroids render it possible to reduce appreciably the amount of systemic steroids.

Subconjunctival injection therapy is often valuable in the management of juxtapapillary choroiditis, in permitting the reduction of systemic therapy in many patients, and especially in those in whom medical complications seem to contraindicate large doses of systemic therapy, as well as in those who are unreliable in taking their therapy. When it functions, it is generally dramatically. When it does not, it does no apparent harm.

There has been no attempt to routinize therapy. A constant effort has been made to keep patients at the minimum necessary maintenance dosage. They have been taught to employ their steroids much as a diabetic is taught to employ insulin. When vision is worse and they are unable to come in immediately, they increase the dosage, and when they are doing well, they decrease the amount. Many of the patients have learned to recognize the onset of secondary glaucoma by halos and haziness of the vision, etc., and immediately employ a carbonic anhydrase inhibitor. Patients who have recurrent disease keep a small supply of medication on hand and take it when a recurrence is suspected.

In Table 1 the term "rebound permitted" occurs. This refers to the fact that the patient has suddenly discontinued therapy or has had his therapy abruptly interrupted, following which a marked exacerbation of the disease has occurred. In most of the failures a rebound phenomenon has been permitted to occur. The patient with Behçet's syndrome had been on the highest dosages which I have employed, was hospitalized in his home state, and therapy stopped abruptly. He lost the vision in one eye and suffered a severe exacerbation in the other so that he was never again controlled and eventually lost the use of that eye. A second patient (Case 72) became ill at home and stopped his therapy for two weeks. He lost the vision in that eye. A third patient (Case 46) had an acute appendicitis and was hospitalized, with discontinuance of his medication. This patient suffered a severe rebound and, in addition, almost lost his life, until the surgeon was persuaded to restart the steroid therapy. However, the eye was ultimately lost, possibly because of the severe rebound phenomenon which occurred. It is a *sine qua non* of steroid therapy that one must never discontinue steroids abruptly when the patient is on a relatively high dose but must always taper off as slowly as possible. If, for some important reason, it seems neces-

sary to discontinue the steroids abruptly, one should always give a sub-Tenon's injection of 12.5 mg. of cortisone or its equivalent in another steroid.

In long-term therapy it may be necessary to maintain treatment for weeks to months before a beneficial response is noted. This is disconcerting, since one of the rules of therapy states that when a response does not occur, it must be presumed that the patient is receiving either an inadequate dose or the wrong steroid preparation for him. It is impossible to lay down hard and fast rules as to initial dosage, but if the patient is on approximately 10 to 12 tablets of any of the oral steroids mentioned, including 0.5 mg. tablets of dexamethasone, it must be presumed that he is on an adequate dosage and a trial of at least a month or two must be given. If he is on less than this amount, the dosage should be increased to 10 or 12 full tablets for an adequate trial of several weeks to a month. If there is no evidence of improvement in that period of time, he should be switched to an alternative preparation; this move will frequently be successful. I have not had any patients who have done well on prednisolone when they have failed on prednisone or vice versa, as these two preparations are similar in action. Intravenous infusions of corticotropin with a minimum of 25 units in 1,000 cc. of saline solution regulated to drip at 20 drops per minute with a consequent duration of 12 to 16 hours may be one of the most important methods at the ophthalmologist's disposal in a refractory case. This makes for good initial therapy in a severe case and may then be followed by either intramuscular corticotropin or oral steroids.

When one eye is involved with uveitis, the dosage must be regulated by the amount necessary to suppress the inflammation in that eye. When both eyes are involved but are useful organs of vision, the amount employed must be that which will control the inflammation in both eyes. When both eyes are involved and one is hopelessly blind, as for example, due to an old uveitic detachment, the dosage should be that amount necessary to control the seeing eye. This will usually be insufficient to control the blind and often worsely inflamed eye. When both eyes are involved and one is blind due to some condition which possibly can be remedied in the future, such as a uveitic cataract, the dose should be that amount which will control both eyes, since it may be necessary later to perform surgery on the other eye. If both eyes seem to be hopelessly involved, but there is still some vision, if only light perception, the ophthalmologist should do everything at his command to attempt to salvage something from the wreckage. At times this is possible.

The commonest question which is raised concerns the use of steroid therapy in "granulomatous" uveitis. From time to time the literature[2,3] rediscovers toxoplasmosis or tuberculosis or one of the other granulomatous diseases and quotes an impressively high percentage of successes. It is impossible to account for this. I have employed the various antigranulomatous regimens from time to time without an impressive degree of success. It is noteworthy that many of the patients in the literature have had concurrent steroid therapy which has not been given much if any credit for the results. Certainly if one has presumptive evidence of tuberculosis, toxoplasmosis, or other granulomatous disease, there is no objection to employing the recommended concomitant therapy. Given a case which has not responded to an adequately long period of steroid therapy, one should empirically employ either an antituberculous or an antitoxoplasmosis regimen long enough to see if this will help.

Steroid therapy will not melt old healed tubercles or scars due to tuberculosis, sarcoidosis, toxoplasmosis, etc. However, if these organisms are present during an acute infectious disease, the steroids in adequate doses should suppress the inflammatory reaction, promote local absorption of the medication, and prevent encapsulation of the organisms while the so-called "specific therapy" destroys the organisms. This has

proved[4-7] successful in the treatment of pulmonary and meningeal tuberculosis, systemic sarcoidosis, etc. I feel that true infection is present rarely in endogenous uveitis and that therefore this accounts for the paucity of good results in my hands with so-called specific therapy. Nevertheless, in the patient who does not respond, everything should be tried, if only in desperation. Occasionally success will occur.

Secondary glaucoma can usually be controlled with carbonic anhydrase inhibitors plus an increase in the systemic steroids or the addition of subconjunctivally injected steroids or both.

I do not employ cycloplegics routinely in the treatment of uveitis except in patients who have a central choroiditis in their only eye. If they have vitreous membranes, they appreciate the cycloplegia, as it enables them to look around the membranes. Otherwise cycloplegics are unnecessary, since recent synechiae will usually lyse under steroid therapy and at times old synechiae have similarly melted away.

There are too many misleading clues in the evaluation of the etiology of any disease. This justifies a reasonable period of so-called specific therapy for tuberculosis or toxoplasmosis on an empirical basis especially in desperate cases, when other treatment has failed. One of my patients (Case 57) had an acute disease which was diagnosed as infectious mononucleosis. After this he lost the central vision in one eye. He was seen by a succession of ophthalmologists, one of whom referred him here. Meanwhile he had developed a peculiar large white area at the bifurcation of a major vessel above the macula, with a veil coming down into it. Vision of 20/200 was accompanied by psychotic symptoms based upon a fear of going blind. His skin test for toxoplasmosis was negative, and a thorough hospital search for etiology was unrevealing. The diagnosis of infectious mononucleosis was never substantiated. A search for some other form of blood dyscrasia via liver punctures, etc., proved unrevealing. In the meantime, two blood tests for toxoplasmosis gave varying degrees of positive results. A third one which was performed under the direct supervision of Dr. Leon Jacobs, of the National Institutes of Health, was positive in a titer of 1:64,000. In the interim, on intravenous corticotropin followed by dexamethasone in daily doses of 4.0 mg., he had rapidly improved to 20/50 and continued to improve. After this he was placed on a combination of pyrimethamine and sulfadiazine, which made him ill with nausea and vomiting. He was continued on this for four weeks when he finally refused to continue. In the meantime, a week after the 20/50 vision was recorded, he had improved to 20/30+ and another week later to 20/20+. The improvement was obviously attributable to the steroid therapy; the specific therapy here was employed in the hope of preventing a recurrence. It is still too soon to tell whether this will prove true. Another patient (Case 78) had two negative blood studies for toxoplasmosis as well as a negative skin test in the hands of the ophthalmologist who later referred him to us. Finally, when some new material was used by that same ophthalmologist, he had a 4+ skin test to toxoplasmosis. However, his severe choroiditis had cleared up meanwhile on steroids followed by artificial fever therapy. I have been told of several cases who had not responded to long courses of steroid therapy but who had responded later to courses of isonicotinic acid, PAS, and streptomycin. I do not doubt these. One of the physicians who told me of having such an experience spoke in terms of "fantastic doses of steroids." This turned out to be two injections of corticotropin a week. Another patient (Case 92) with macular choroiditis in her only eye came in exhibiting progression of the lesion. The referring ophthalmologist said that he used "your method of large doses." She had never had more than 4 tablets daily. When the dose was doubled, the lesion healed promptly. One cannot talk in terms of courses of any therapy unless he delineates the exact amount employed.

The criteria of uveitic activity are decrease in vision, anterior chamber beam and cells, wet keratitic precipitates, vitreous haze or membranes, retinal edema, soft choroidal lesions, engorgement and tortuosity of the retinal veins with or without perivasculitis in the form of white lines around the vessels, and hyperemia or actual engorgement of the optic nerve or even a true papillitis. Progress implies improvement in any of these. At times the ophthalmoscope or slit-lamp picture does not appear changed, and yet the patient has a dramatic improvement in vision, which is considered a signal for a decrease in the amount of medication. Experience has proved this to be a good sign.

I am willing to let my results speak for themselves. In analyzing my failures in retrospect, I am unable to account for them. Practically all occurred in patients who exhibited massive virtual choroidal abscesses involving almost the whole superior or inferior globe. There have been successes in cases like these, but consistently these have been the worst problems. Certainly those which followed a rebound have their own moral—that one must never permit a rebound to occur. At least one of the failures occurred in a man (Case 29) who had never had a rebound and who was improving when the eye suddenly collapsed with marked exacerbation and increase in the choroiditis and loss of vision. I cannot account for this occurrence. A similar situation occurred in the man who had had the appendectomy and in whom rebound was permitted. After the appendectomy, there was some improvement in vision under steroid therapy, followed by sudden collapse of the globe. At least two of the patients in this series presented evidence of "choroiditis" in which there has never been any pigment or cells in the vitreous or in the aqueous. I have seen other cases such as this. These are probably not true cases of choroiditis. One has responded well to therapy and one equivocally. I have seen a number of cases of so-called "central serous retinopathy," most of which have been successfully treated and the bulk of which have not been included in this paper because of the short duration of therapy. Artificial fever therapy induced by intravenously injected typhoid antigen has not proved particularly successful in my hands. Perseverance is probably the greatest factor in making for success.

It must be emphasized that there is no such thing as a "course of treatment." A course of treatment is enough, given long enough and often enough to secure the result that is desired. Anything short of this is a waste of time and the patient's eye.

### "Hopeless" Disease

It has become fashionable during the past decade to state that "steroids do not cure anything" and that steroids are of no value in degenerative conditions of the eye. Actually this is not true. If by a "cure" one means the destruction of the pathogenic mechanism, it is probably true that in ophthalmology steroids do not cure anything. If by "cure" one means suppression of the disease until the pathogenic mechanism burns out, then steroids cure many conditions. The second point—that steroids are of no value in degenerative eye diseases or in hopeless eye diseases—is also untrue. I have treated a number of cases of so-called "hopeless" eye conditions over a period of years with varying degrees of success but with some successes. I have spoken to a number of physicians who have had similar experiences. For example, Frank Walsh [8] has told me of a patient who lost the vision in one eye due to a central vein thrombosis and who later lost the vision in the other eye with the same disease. In desperation Dr. Walsh employed systemic steroids with remarkable visual improvement.

Three cases will illustrate some of my experiences. A man of 70 who had macular degeneration with hard plaques in one eye and 20/15 vision and several hard plaques on the periphery of the other macula called one day to say that he had suddenly lost most of his vision and that

what remained was very distorted. When the patient was seen, his vision was a poor 20/25 but the macula was edematous. Three weeks of systemic steroids restored the vision to the 20/15 level. The macula now appeared to be normal and free of the edema. The visual improvement here was undoubtedly due to symptomatic removal of the edema by the steroids. While it is very probable that this situation will recur, the man has now been free of any untoward symptoms for approximately nine months. A second patient, a high myope with useful vision in but one eye, suffered a loss of vision to the 20/200 level several months before being seen by me. He was treated by another ophthalmologist for two months and told that he was "hopeless." When seen, corrected vision was 20/200 and the macula appeared granular but not edematous. This patient improved to 20/30 on systemic steroids; when the level of steroids was dropped radically, the vision dropped to 20/50 and again improved to 20/30 on increase of the dosage. The improvement in vision apparently was due to the removal of edema which disappeared as a result of the antiedematous properties of steroids. A third patient, a high myope with cracks in both macular areas, came in with hemorrhages in both maculae and reduction of vision to 20/60. He was placed first on intramuscular injections of 100 mg. of heparin sodium twice weekly until the hemorrhages were largely absorbed, after which he was given systemic steroids. The vision improved to 20/30 and 20/20. These are but several of the examples of "hopeless" situations which have been helped. At times other therapies, such as heparin sodium, trypsin, streptokinase, and streptovaridase, have been used. I have not healed any choroidal scars nor improved any cases of optic atrophy nor done the impossible. The point is that today we do not always know what is impossible. I have had success in cases where I felt that I had removed retinal edema, or in patients with apparently inactive uveitis I may have reactivated certain cells which, while not functioning, were not dead. This is certainly hypothetical but is a possibility which must be considered. In connection with this, Walter Palmer [9] told me of a patient who lost his vision due to uveitis in presteroid days; when he was later placed on long-term steroids for his ulcerative colitis, he recovered useful vision. This is a different situation from some of the cases of chronic severe uveitis in which the irides are all bound down and in which there are dense vitreous membranes. Under prolonged steroid therapy, some of these pupils have reopened, and the vitreous membranes cleared markedly.

### Side-Effects

The most feared complications during prolonged steroid therapy are gastrointestinal ulcers and psychoses. Very early in my experience, two patients who are not in the group recorded here became psychotic but recovered. Another patient with retinitis pigmentosa became mildly psychotic while under therapy and also recovered. He had had a similar attack two years before when not under any treatment. Another patient, Case 33, was psychotic when referred by her ophthalmologist while under corticosteroid therapy. Later it became obvious that she was psychotic because, while under steroid therapy on three different occasions, she had suffered a severe relapse in her only functioning eye. Her psychosis seemed to be based on the fear of blindness. When it became apparent that this was not to be the case, the psychosis disappeared. A man with a family history of psychoses (Case 21, Behçet's disease) became psychotic after being permitted to suffer a rebound phenomenon, after which he lost one eye and suffered irreparable damage in the other. He was treated successfully with shock therapy while under concomitant corticotropin therapy. Many patients with chronic disease act psychotic owing to fear of the disease. Many become "jittery," nervous, insomniac, euphoric, or depressed under steroid therapy. They can be usually controlled with

tranquilizers. One patient under treatment with dexamethasone complained of becoming so "jittery" that he was compelled to stop treatment. A short time later when a dexamethasone tablet of different size, color, and shape was prescribed, he had no complaints and continued treatment. A history of gastrointestinal ulcers or of gastric disturbances in a patient requiring systemic steroid therapy indicates an immediate ulcer regimen. The ophthalmologist who lacks experience with systemic steroid therapy is advised to secure the immediate cooperation of the family doctor or internist when side-effects threaten to occur. However, unless the consultant is skilled in steroid therapy, he may cause more damage than good by additionally frightening the patients with warnings against "those terrible drugs." When one feels that the services of the patient's family doctor or internist are required, he should consult with him and ascertain his experience and views.

There have been no psychoses in this series other than those mentioned, and there have been no psychotics who did not recover from their mental disturbances while under treatment. No patients have been known to develop gastrointestinal ulcers in this series. Some patients with ulcers have been seen and treated successfully. The patient with Behçet's syndrome developed tarry stools while under steroid therapy. He was continued on this therapy when the x-rays did not reveal any gastrointestinal pathology. Three patients are known to have osteoporosis. One, a physician over 70 years of age, was discovered to have osteoporosis after a serious automobile accident in which two of his vertebrae were fractured. He suffered approximately six to eight weeks of discomfort, after which there was virtually no complaint of pain. He has continued his practice. Systemic steroids were discontinued. He has been controlled excellently in one eye and fairly well in the other with topical steroids. A woman of approximately 70 (Case 6) was discovered to have osteoporosis on routine physical examination. She has had no symptoms. The man with Behçet's syndrome who has had the most intensive systemic therapy of any of my patients developed symptomatic osteoporosis. His fractured vertebrae were well managed by bed rest, a back brace, and physical therapy. It must be emphasized that osteoporosis occurs spontaneously in a high percentage of persons over 60 without steroid therapy and is usually either asymptomatic or relatively unimportant.

Virtually all patients who are under long-term systemic steroid therapy will exhibit water retention varying from a moon face to important weight gain. This is rarely a problem, since it can be managed readily with diuretics, such as chlorothiazide and intramuscular mercuhydrin, plus potassium orally. If there is concomitant secondary glaucoma, one of the carbonic anhydrase inhibitors is employed in the management of both the water retention and the secondary glaucoma.

Acne has occurred in relatively few cases and has been easily controlled by topical applications of steroids or by reduction of the dose of the steroids. Originally I employed estrogenic substances to control acne, but more recently I have found that the topical steroid preparations are more effective and easier to use. Hirsutism has been an infrequent complication which disappears as the dose is reduced or is ultimately discontinued.

Two patients who were on systemic steroids as well as oral diuretics developed unimportant subconjunctival petechiae and one, similar occurrences in the skin. These had been attributed to steroid therapy. However, a recent report [10] sites a case of purpura caused by a carbonic anhydrase inhibitor.

Chronic intraocular inflammatory disease can usually be successfully managed with a sustained regimen of corticosteroids plus specific therapy when the latter is available. The etiology of these devastating inflammations can rarely be pinpointed. An intelligent regimen tailored to the individual

patient and altered as the need arises makes for a rational approach to therapy. The alternative is usually blindness. It must be emphasized that a "positive" test is not proof of the cause of a uveitis.

Ninety-three patients with severe therapeutic problems who have been treated for three months to nine years or more are reported and analyzed. Twenty-three of these were dependent upon the affected eye because of blindness or central scarring in the contralateral globe. Seventy-nine are considered as controlled or have achieved a biologic cure. Six are rated as equivocal and eight as failures. Most of the latter occurred in patients whose therapy was stopped abruptly while at a high dosage level, permitting a rebound phenomenon to occur.

Some of the chronic degenerative diseases of the eye can also be aided or controlled by this regimen. This group is discussed briefly in an attempt to encourage widespread trials of therapy in these otherwise hopeless situations. Here failures will outnumber successes, but each success is a noteworthy landmark.

441 E. 68th St. (21).

## REFERENCES

1. Offret, G., and Haye, C.: Results Obtained in the Treatment of Uveitis with Cortisone: Five Years Experience, Arch. opht. 16:261, 1956.

2. Edwards, J. E., and Erdbrink, W. L.: Practical Management of Granulomatous Chorioretinitis, A. M. A. Arch. Ophth. 61:226, 1959.

3. Cassady, J. V.: Toxoplasmic Uveitis, A. M. A. Arch. Ophth. 58:259, 1957.

4. Levine, E. R.: Personal communication to the author.

5. Smith, M.: Personal communication to the author.

6. Riemer, A. D.: Personal communication to the author.

7. Harris, M. S.: Personal communication to the author.

8. Walsh, F.: Personal communication to the author.

9. Palmer, W.: Personal communication to the author.

10. Horowitz, H. I.; Shapiro, B., and Rubin, I. L.: Athrombocytopenic Purpura Caused by Chlorothiazide, New York J. Med. 59:1117, 1959.

# Therapeutic Keratoplasty in Mooren's Ulcer

PHILIP C. GRANA, M.D., Braddock, Pa.

This paper reports a case of Mooren's ulcer in which therapeutic keratoplasty resulted in arrest of the disease and preservation of useful vision. The medical and surgical measures employed without success are given. Two grafts were done. The reaction in the first graft is noteworthy in that a typical Mooren's-like ulcer developed in the graft itself and then progressed into the remaining uninvolved cornea. The indications for therapeutic keratoplasty are given. A brief résumé of some of the forms of treatment reported in the literature is included.

Therapeutic keratoplasty has become a useful tool in the management of a variety of corneal pathologic processes. Its primary objective is the arrest of the disease. Therapeutic keratoplasty, usually, if not always, employs the lamellar technique. The procedure is safer than the penetrating type. Recently the uses of lamellar keratoplasty have been greatly extended not only in this country but particularly in Europe. Franceschetti,[1] Paufique,[2] Rycroft and Romanes,[3] Paton,[4] Castroviejo,[5] and others have reported on its value. Paufique[2] has stated that the trophic action of the graft is interesting; its beneficial effect on the remaining cornea is frequently surprising as lesions improve and symptoms subside.

## Indications

The indications for lamellar graft may be listed as follows:

(1) Improvement of the architecture in preparation for full thickness graft later, as in vascularized scars and thin corneas
(2) Esthetic, which is rarely done
(3) Therapeutic
  (*a*) Stop malignant pterygium
  (*b*) Ruptured descemetocele
  (*c*) Keratoconus

Submitted for publication Feb. 11, 1959.



## Clinical Picture

Briefly, Mooren's ulcer can be defined as a chronic disease of the cornea of unknown etiology. It begins near the limbus as a grayish infiltrate. This breaks down to form an ulcer characterized by a trough with an overhanging edge that progresses relentlessly, leaving in its wake a thinned, clouded cornea. The healed portion is devoid of Bowman's membrane and the anterior lamellae. It is vascularized, and the epithelium is thickened, covering a thin scar. The end-result is a severe impairment of vision. It is an affliction of the aged, although it has been reported in younger groups. Duke-Elder[6] states that bilaterality occurs in about one-fourth of the cases. Perforation is rare. Progress is slow.

Pathologically, there is a necrotic process with round-cell infiltration. As mentioned, Bowman's and the anterior lamellae are destroyed.

The etiolgy is by no means established. A variety of organisms have been indicted, including tubercle bacillus, diplo bacillus, and others. Metabolic disorder, trophic disturbance, vitamin deficiency, and other factors have had their exponents.

The symptoms include pain, which, however, is not always present; photophobia, and lacrimation. Injection of the globe is surprisingly mild.

The treatment is both difficult and varied, as evidenced by the report of Linn,[7] in 1949. A total of 53 cases is listed in which cures were obtained. Some forms of treatment are not given in his paper because definite cases are not cited.

The methods reported are as follows:

(1) Cauterization
  (*a*) Chemical agents
  (*b*) Physical agents

(2) Paracentesis or delimiting keratotomy
(3) Conjunctival flap alone or with other measures
(4) Chemotherapeutic agents
(5) Radiation
(6) Miscellaneous forms of therapy

### Report of Case

A 69-year-old white woman was first seen on Feb. 26, 1954, at which time she gave a history that the right eye had been red for a period of six months. She complained only of a "jagging" sensation. She was treated elsewhere with local corticosteroids.

Physical examination was essentially negative except for an aortic systolic murmur. The lungs were clear. No signs of decompensation were present. Urinalysis was normal. The blood cell count was R. B. C. 4,660,000, W. B. C. 8,400; hemoglobin, 91%; differential count, normal; blood sugar, 83 mg. %.

On initial examination, the vision in each eye was 20/30 corrected. The involved right eye was mildly congested. The temporal margin of the cornea was replaced with scar tissue and central to this was an undermined area that was stained with fluorescein. Chlortetracycline solution, 1%, was prescribed, and several days later the cornea showed no staining. Two weeks later the area again showed activity, and chloramphenicol, 0.5%, was given. No improvement occurred, and on April 7, 1954, at the Eye and Ear Hospital of Pittsburgh, a conjunctival flap was dissected and the ulcer covered. Antibiotic ointments were used postoperatively. On April 21, 1954, the inferior part of the flap retracted exposing a small sector of the ulcer. The exposed sector began to show activity five days later. The patient was placed on Polysporin (polymyxin B and bacitracin) ointment, and 11 days later 10% sulfacetamide sodium (Sodium Sulamyd) was instituted. The flap further retracted, and on May 19, 1954, the ulcer was again covered by a conjunctival flap. The second flap failed to stay in position, and the flapping was repeated again on May 26 and again for a fourth time on May 29. Several days later the flap retracted, and the ulcer became exposed again. Activity was once more observed, and the ulcer extended. Bacitracin and Polysporin ointments were tried in succession. Neocortef (hydrocortisone acetate and neomysin sulfate) ointment was tried, and the ulcer showed some signs of healing for a while, but it then progressed again.

The patient was readmitted to the Eye and Ear Hospital, and on July 29, 1954, a partial lamellar keratoplasty was done under thiopental anesthesia. The recipient site was prepared by curettement of the epithelial layer covering the scar, and the overhanging edge was cut away. The graft was sutured in place with interrupted black nonabsorbable surgical (silk) sutures. At the time of the operation the graft was trimmed a little too small, and a good fit was not obtained in the superior temporal edge bordering the uninvolved cornea.

Postoperatively some vascularization was noted. Locally, atropine sulfate 1% solution, chloramphenicol ointment, and Neocortef ointment were used.

By Aug. 21, 1954, almost two months after the lamellar keratoplasty, there was evidence of infiltration of the graft itself by undermining. The process resembled a Mooren's-like ulcer in the graft itself. The patient complained of pain and epiphora at this time. By Nov. 2, 1954, the graft had all but disappeared.

On Nov. 3, the patient was readmitted to the Eye and Ear Hospital and a paracentesis was done in the uninvolved cornea. The paracentesis was kept open for 18 consecutive days. By this time, the cornea was from 1/3 to 1/2 replaced by scar and the advancing border showed staining. The patient complained of much photophobia and lacrimation. An opinion was obtained from Dr. William F. Hughes Jr.[8] on the advisability of $\beta$-radiation. He stated, "We have never used beta radiation on Mooren's ulcer because we have felt that this degen-

erative process might be hastened by further exposures to injurious agents. There are a few such cases treated in the literature by radiation, and the results have been uniformly poor. Since there is no evidence that Mooren's ulcer is related to an infectious process, I do not even believe that very small doses of radiation, in order to increase immunity, would be of any theoretical help."

On. Jan. 7, 1955, the lamellar keratoplasty was repeated. The scarred area was again prepared by curettement of the epithelial layer for the reception of the donor graft. The ulcer became active again. The overhanging edge was removed by scissors dissection and touched with iodine, 3½%, and alcohol. The vision was now 20/100 with correction in the involved eye. The ocular tension, taken with a Schiøtz tonometer, was 23.4 in each eye. The activity continued, and the ulcer was treated with 1% silver nitrate. On April 14, 1955, it was healed. For about a year, a very faint stain was noted on and off. Part of the transplant had been replaced by scar tissue. On May 19, 1956, the eye was healed and corrected vision was 20/40. When the patient was last seen on Nov. 22, 1957, the corrected vision was 20/50− and the eye was healed.

## Comment

The use of corneal tissue for the therapy of Mooren's ulcer has been previously reported. DeBerardinis,[9] in 1906, successfully used donor tissue from a rabbit after excising the ulcerated area. Paton[4] reported, in 1954, his results of lamellar keratoplasty in two cases of Mooren's ulcer. The first was in a 48-year-old man who had a dense peripheral opacity with a number of vessels. Preoperative vision was hand movements. Postoperative vision was the same; however, the ulcer was arrested. The second patient had a 6 mm. graft that remained clear. Preoperative vision was 20/100 with correction. The postoperative vision was 5/100 unimproved. Barraquer[10] reported a case. Postoperatively the graft developed a loss of transparency, beginning about the 20th day. The cornea became turbid, thickened, and showed vesiculation in places.

Monfette,[11] in 1949, presented a case of Mooren's ulcer in which a ring-shaped lamellar graft was done on a patient with only one eye. The other eye was previously enucleated for a similar lesion. The patient had received a variety of medical and surgical treatments. Prior to keratoplasty the vision was 15/100. The cornea became opaque 40 days postoperatively, but the evolution of the disease was arrested. The vision was counting fingers at 1 ft. Rocha and Coscarelli[12] reported two successful cases and one failure in the treatment of Mooren's ulcer with keratoplasty. Sourdille,[13] in discussing Boudet and DeJean's case, stated that he had only one failure in five cases of Mooren's ulcer treated with keratoplasty. Offret,[14] in discussing the same case, reported one success and one failure.

A patient with Mooren's ulcer has been presented. The difficulties encountered in the management of this case are similar to the experiences of many others. No one particular method of therapy producing a good effect has been universally successful. This is obviously so because the disease is rare and poorly understood.

Several points are of interest in this case study. First, the apparent failure of a variety of antibiotics and corticosteroids applied locally to cure the disease is noted. Second, the conjunctival flaps appeared to arrest the progress of the disease as long as they remained in place. This is subject to the criticism that the remission was spontaneous.

The erosion of the first graft deserves comment. Boase,[16] in 1955, reported a Mooren's ulcer in a corneal graft. He did a lamellar transplant on a patient with complete opacification of the cornea. The transplant became clouded about 10 days later, and in about three months it showed evidence of a Mooren's ulcer. The graft went on to complete erosion. In his discussion he questioned the original diagnosis be-

cause of the lack of postinflammatory iris changes and the lack of conjunctival discharge. He felt that the original opacification could have been a Mooren's ulcer. Scheie and Hicks[16] likewise reported a similar experience in two patients with a Mooren's-like ulcer in the grafts. Their cases were treated for recurrent herpetic keratitis.

DeJean and Boudet,[17] in 1952, also reported a recurrence of Mooren's ulcer in a corneal graft. The reaction in this patient was clinically the same in the first graft as in the Mooren's ulcer itself. There were undermining and necrosis until the entire transplant was replaced by a vascularized scar. Scheie and Hicks[16] suggested as one possibility that the graft reactions in their cases might be due to the vascularity and scarring of the recipient cornea. A thin veil of hemorrhage was noted between the graft and patient cornea in both instances in the case presented here. Another possibility was the poor fit in the upper temporal sector of the first graft, allowing it to become epithelized first along the separation and then along the bed of the graft. Shafer,[18] in 1950, reported such an occurrence in experimental lamellar grafts in rabbits. The second keratoplasty performed on this patient showed some uncertainty as to taking postoperatively, and small areas of stain were observed at intervals for some time. It is difficult to say why the second graft did not go on to complete dissolution. Perhaps the donor material was more compatible. That the second keratoplasty can take credit for eventual healing here cannot be accepted without some reservation. In spite of the partial scarring, most of the donor cornea remained clear. The scarred portion itself became less opaque in time. It was felt that the eventual visual result was satisfactory.

## Summary and Conclusions

A case of Mooren's ulcer which was successfully treated, resulting in the preservation of useful vision, is presented.

The medical therapeutic measures which failed are included in this report.

The following surgical procedures were used: (*a*) conjunctival flaps (four times) with temporary arrest of the disease; (*b*) paracentesis (daily for 18 days) with no effect; (*c*) lamellar keratoplasty (twice) with invasion of the first graft by a Mooren's-like ulcer and eventual loss of the transplanted tissue. The second graft resulted in a cure and arrest of the disease.

The further use of lamellar keratoplasty in the therapy of Mooren's ulcer and other corneal diseases is encouraged.

422 Library St.

## REFERENCES

1. Franceschetti, A.: The Different Techniques of Corneal Grafting and Their Indications, Am. J. Ophth. 39:61-66 (Jan.) 1955.

2. Paufique, L.: Corneal Transplantation: Indications for the Therapeutic Lamellar Corneal Graft, Am. J. Ophth. 33:24-25 (March) 1950.

3. Rycroft, B. W., and Romanes, G. J.: Lamellar Corneal Grafts: Clinical Report on 62 Cases, Brit. J. Ophth. 36:337-351 (July) 1952.

4. Paton, R. T.: Corneal Transplantation: A Review of 365 Operations, A. M. A. Arch. Ophth. 52:871-916 (Dec.) 1954.

5. Castroviejo, R.: Indications and Contra-Indications for Keratoplasty and Keratoctomies, Tr. Am. Ophth. Soc. 43:324-330, 1945.

6. Duke-Elder, W. S.: Text-Book of Ophthalmology, Vol. 2, St. Louis, The C. V. Mosby Company, 1938, p. 1929.

7. Linn, J. G.: Chronic Serpigenous Ulcer of the Cornea (Mooren's Ulcer): Etiologic and Therapeutic Consideration, Am. J. Ophth. 32:691-698 (May) 1949.

8. Hughes, W. F., Jr.: Personal communication to the author, 1954.

9. DeBerardinis, D.: L'Ulcera rodente della cornea curate mediante la eteroplastia di tessuto corneale di coniglio, Ann. ottal. 35:835, 1906; Abstracted, Ophth. Rev. 26:88, 1907.

10. Barraquer-Moner, J. I.: Queratoplastia, Barcelona, Instituto Barraquer, 1948, Plates II and XIV.

11. Monfette, C.: La Greffe lamellaire de la cornée dans l'ulcere de Mooren, Union méd. du Canada 78:1322-1323 (Nov.) 1949.

12. Rocha, H., and Coscarelli, E.: A Ceratoplastia lamelar no ulcus rodens, Rev. brasil. oftal. 14:355-368 (Sept.) 1955.

13. Sourdille, G. P., in discussion of Boudet and DeJean.[17]

14. Offret, G., in discussion of Boudet and DeJean.[17]

15. Boase, A. J.: Mooren's Ulcer in Corneal Graft, Brit. J. Ophth. 39:182-183 (March) 1955.

16. Scheie, H. G., and Hicks, J. D.: Mooren's-like Ulcer in a Corneal Graft, Am. J. Ophth. 43: 385-388 (March) 1957.

17. DeJean C., and Boudet, C.: Récidives d'ulcus rodens sur des greffes de cornée, Bull. Soc. opht. France, pp. 32-34 (Jan.) 1952.

18. Shafer, D. M.: Corneal Transplantation: Experimental Lamellar Grafts, Am. J. Ophth. 33: 26-31 (March) 1950.

# Subdural Membrane with Arachnoiditis of the Optic Chiasm

*A Clinical and Pathological Report*

MARTIN M. MANDEL, M.D., and CHARLES G. STEINMETZ III, M.D., Philadelphia

Arachnoiditis involving the optic nerves and chiasm has been reported previously by Heuer and Vail[4] (1931), Craig and Lillie[1] (1931), and Ryan[7] (1943). Except for Davis and Haven's[3] study of the arachnoid membrane (1931), the reported cases were clinical and surgical without microscopic study of the adhesion or cyst. The clinical concept of arachnoiditis does not appear to be clearly defined in previous reports, for Walsh[8] stated that he was skeptical regarding its existence. The recognition of arachnoiditis is of great importance, since it frequently produces a chiasmal syndrome which simulates a suprasellar neoplasm or aneurysm. Further, with lysis of adhesions or release of cystic collections of fluid by surgery, many have obtained improvement of vision. The occurrence of a free subdural membrane with arachnoiditis of the optic nerves and chiasm after spinal anesthesia and meningitis has not been previously noted. The following case is, therefore, presented together with a microscopic study of the biopsy material to substantiate arachnoiditis as a definite clinical and pathological entity.

## Report of a Case

A 33-year-old secretary was admitted to the Jefferson Hospital on Sept. 23, 1958, with the complaints of loss of vision and severe headaches.

She stated that on March 21, 1957, she had a hemorrhoidectomy with spinal anesthesia. Two days later, she noted "fever, headache, and stiffness of the neck." She was told that she had "meningitis" and was treated with intravenous and oral sulfonamides. She recovered after a two-week period but complained of intermittent headaches.

Six months prior to admission to the hospital, she noted "dimmed vision" which affected the left eye. Her vision became progressively worse in the left eye during the next few months, and her headaches became severer, and so little relief was obtained with acetylsalicylic acid. Large doses of codeine were necessary to relieve her daily headaches, and other analgesics were not effective. The headaches which had been generalized earlier became localized behind the left eyeball. Three months later, she became aware of a defect in the left superior nasal field which was manifested by a "blind spot on the page of writing." By this time the vision in her left eye became worse, and reading of small printed matter became exceedingly difficult. At this time, she failed an automobile driver's examination because of her poor vision.

In addition to her headaches and visual complaints, the was aware of intermittent "numbness and tingling sensations in the left and right hands." There was no accompanying weakness of the upper and lower extremities.

She denied polyuria, polydipsia, or irregular menstrual periods.

Neurologic examination revealed the pupils to be round, regular, and equal with prompt reaction to direct light and accom-

Submitted for publication Feb. 20, 1959.

From the Department of Neurology (Dr. Mandel) and Department of Ophthalmology (Dr. Steinmetz) of The Jefferson Medical College.

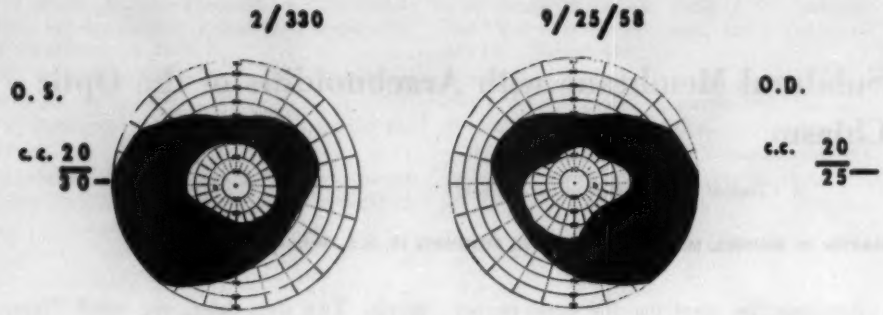



Fig. 1.—Peripheral visual fields prior to surgery.

modation. Consensual light reflex was present. There was pallor of the temporal margin of the left optic disc. The retinal vessels were normal, and there was a good macular reflex bilaterally. The visual acuity of the right eye was 20/200 without correction, and she could only count fingers at a distance of 18 in. with the left eye without correction. With lenses, her corrected visual acuity was 20/25 in the right eye and 20/40 in the left eye. The central visual field of the right eye was constricted with a superior temporal cut. In the left central visual field, a cut was present in the superior temporal

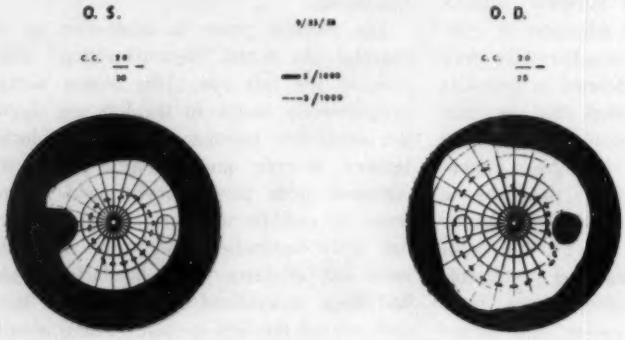



Fig. 2.—Central visual fields prior to surgery.

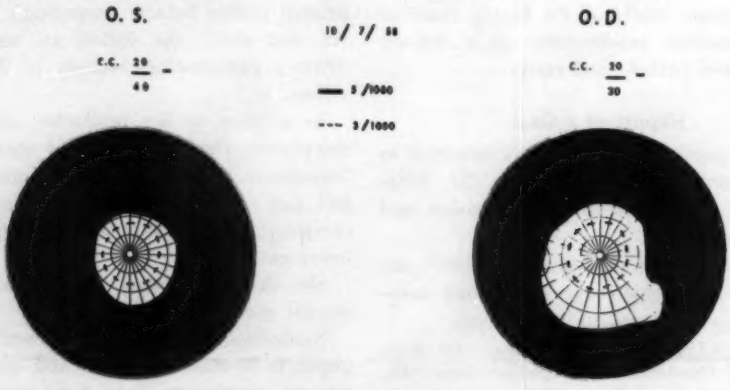



Fig. 3.—Central visual fields prior to surgery.

and nasal fields (Figs. 1, 2, and 3). The remainder of the neurologic examination revealed nothing significant.

A complete blood cell count and a urinalysis were normal. Lumbar puncture yielded clear, colorless spinal fluid under an initial pressure of 130 mm. of water. The total protein content of the spinal fluid was 50 mg/100 cc. The Wassermann and Kahn reactions of the blood and spinal fluid were negative. The electroencephalographic tracing was slow in all leads. Roentgenogram of the skull was normal.

*Course.*—On the basis of the history and neurologic findings, it was felt that the patient has a chiasmal syndrome associated with either an arachnoiditis or a suprasellar aneurysm or tumor. With the history of meningitis following spinal anesthesia and the constricted visual fields and field defects, arachnoiditis appeared to be the most probable diagnosis.

A pneumoencephalogram was performed. This revealed poor and incomplete filling of the chiasmatic cistern which was suggestive of a chiasmatic arachnoiditis. Right and left internal carotid arteriograms failed to demonstrate a suprasellar lesion in the form of an aneurysm or tumor.

Her visual acuity in the left eye became worse during the period of her studies. In addition, she noted blurring of vision in the right eye. In view of the rapid visual loss and findings of poor filling of the chiasmatic cistern, exploration of the chiasmatic region was indicated.

A frontotemporal craniotomy was performed on the left side. A sheet of subdural membranous tissue was found at the base of the brain, and it covered the entire temporal lobe. It was opalescent and completely separate from the dura and arachnoid. This membrane, though only a fraction of a millimeter in thickness, was avascular and was wrapped around the veins in the sphenoid ridge area. As the membrane approached the optic chiasm it became attenuated, but it was still present over the optic nerves and left internal carotid artery. The right optic nerve appeared pale. A portion of subdural membrane and adhesions from the optic chiasm were removed for study.

Microscopic examination revealed the subdural membrane to be thickened with round-cell infiltration. Examination of the adhesion from the optic chiasm revealed a proliferation of the arachnoidal cap cells with fibroblastic thickening of the arachnoid and round-cell infiltration. This proved to be consistent with a chiasmatic arachnoiditis secondary to an old meningitis.

Her postoperative course was characterized by a marked improvement in her vision, as well as improvement in her visual fields (Figs. 4, 5, and 6). Her visual acuity was 20/80 in the right eye and 20/200 without correction. With lenses, her vision was 20/20 in the right eye and 20/200 in the left eye. Her headaches were diminished and had cleared almost entirely within a month postoperatively.

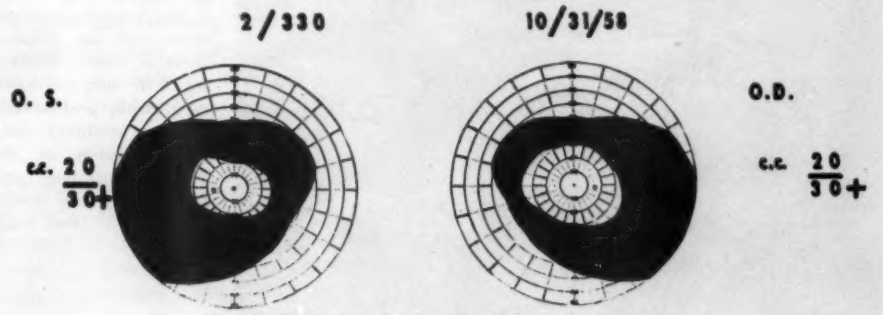



Fig. 4.—Peripheral visual fields 10 days after surgery.

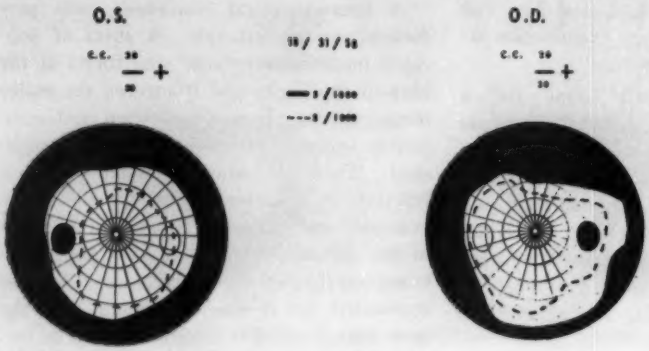



Fig. 5.—Central visual fields 10 days after surgery.

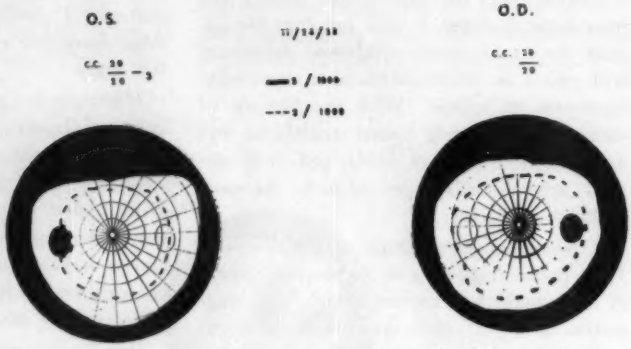



Fig. 6.—Central visual fields 34 days postoperatively.

## Pathology

In a study of cerebral arachnoiditis, Davis and Haven [3] described three types of involvement: inflammatory, fibrous, and hyperplastic. The characteristic changes varied from round-cell infiltration in the inflammatory type of fibrous thickening and proliferation of arachnoid cells in the fibrous and hyperplastic types.

Blocks of tissue from the subdural membrane and adhesion from the optic nerves and carotid artery were stained by the

Fig. 7.—Adhesion from optic nerve and chiasm: there is fibrous thickening of the dura and arachnoid with proliferation of the arachnoid cells and infiltration of the fibrocytes and round cells. Hematoxylin and eosin; reduced 5% from mag. × 200.

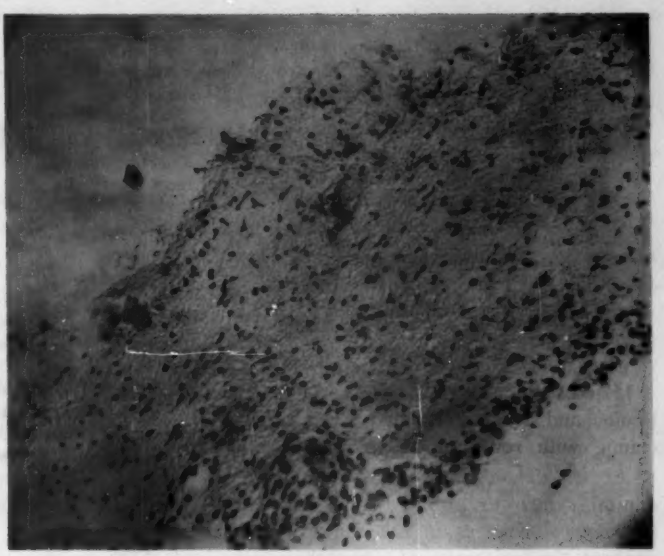


Fig. 8.—Subdural membrane: there is fibrous thickening with round-cell infiltration. Hematoxylin and eosin; reduced 5% from mag × 200.

hematoxylin and eosin method. Microscopic examination of the subdural membrane in our case revealed fibrous thickening with a marked round-cell infiltration (Fig. 7). These changes are consistent with the inflammatory and fibrous changes described by Davis and Haven.[3] The microscopic examination of the thick opalescent adhesion from the optic nerves and internal carotid artery showed pronounced fibrous thickening of the dura and arachnoid with fibrocytes and round-cell infiltration (Fig. 8). The arachnoid cells were proliferated with loss of the normal architecture (Fig. 8). These hyperplastic changes were described previously in another report.[3]

The microscopic findings of round-cell infiltration and fibrous thickening proved to be arachnoiditis of infectious origin. These changes substantiate the existence of chiasmatic arachnoiditis.

## Comment

Chiasmatic arachnoiditis occurs most frequently after chronic infections of the meninges or trauma and is clinically manifested by a slow progressive visual loss with irregular constricted visual field defects and optic atrophy. Yaskin and Alpers[9] reported a Foster Kennedy syndrome with a case of arachnoiditis of the optic nerves and chiasm following trauma. Bitemporal fields defects have also been noted as have central scotomata in other cases of localized chiasmatic arachnoiditis.[1,2,4,6]

In the case reported, arachnoiditis of the optic nerves and chiasm occurred after meningitis associated with spinal anesthesia. The free subdural membrane involving the temporal lobe and chiasm is unusual. Although it did not produce compression of the chiasm, it probably was responsible for the persistent headache, for the headache subsided with the removal of this subdural band. Improvement of vision and visual fields also occurred after craniotomy with removal of adhesions from the optic nerves. This observation was noted by Ryan[7] and Heuer and Vail[4] in their cases. The increased mobility of the chiasm with diminished optic nerve compression are likely factors in the explanation of the clinical improvement following surgery for arachnoiditis. Ryan's[7] results with surgery indicate 50% improvement in his series, but a recurrence of some visual symptoms may occur when the optic nerves and chiasm are intimately involved by thick adhesions and

complete surgical dissection is not possible. The clinical recognition and awareness of the existence of arachnoiditis are important, for improvement is seen with the lysis of adhesions and relief of optic nerve compression.

## Summary

A case of arachnoiditis of the optic nerves and chiasm with a free subdural membrane following meningitis and spinal anesthesia is reported. The subdural membrane which involved the temporal lobe and sphenoid ridge area occurs rarely.

Microscopic examination of the membrane and adhesion revealed fibrous thickening with round-cell infiltration, proving it to be of postmeningeal origin. The clinical symptoms are correlated with the pathological changes in the chiasm. They confirm the existence of opticochiasmatic arachnoiditis as a definite clinical entity. The recognition of this disease in the absence of a suprasellar neoplasm or aneurysm is of importance to the ophthalmologist and neurologist, since surgery is of value in the treatment of these cases.

255 S. 17th St. (3).

## REFERENCES

1. Craig, W. McK., and Lillie, W. I.: Chiasmal Syndrome Produced by Chronic Local Arachnoiditis: Report of 8 cases, Arch. Ophth. 5:558-574 (April) 1931.

2. Cushing, H.: The Chiasmal Syndrome of Primary Optic Atrophy and Bitemporal Field Defects in Adults with a Normal Sella Turcica, Arch. Ophth. 3:505-551 (May) 1930.

3. Davis, L., and Haven, H. A.: A Clinico-Pathologic Study of the Intracranial Arachnoid Membrane, J. Nerv. & Ment. Dis. 73:129-143 (Feb.); 286-300 (March) 1931.

4. Heuer, G. J., and Vail, D. T., Jr.: Chronic Cisternal Arachnoiditis Producing Symptoms of Involvement of the Optic Nerves and Chiasm: Pathology and Results of Operative Treatment in 4 Cases, Arch. Ophth. 5:334-349 (March) 1931.

5. Howell, C. M. H.: Arachnoiditis, Proc. Roy. Soc. Med. 30:33-42 (Nov.) 1936.

6. Lillie, W. I.: Prechiasmal Syndrome Produced by Chronic Local Arachnoiditis: Report of 3 Cases, Arch. Ophth. 24:940-947 (Nov.) 1940.

7. Ryan, E. R.: Optochiasmic Arachnoiditis: Report of 3 cases, Arch. Ophth. 29:818-825 (May) 1943.

8. Walsh, F. B.: Clinical Neuro-Ophthalmology, Baltimore, The Williams & Wilkins Company, 1947.

9. Yaskin, H. E., and Alpers, B. J.: Foster Kennedy Syndrome with Post-Traumatic Arachnoiditis of Optic Chiasm and Base of Frontal Lobes, Arch. Ophth. 34:399-401 (Nov.) 1945.

# Experimental Ocular Infection with Nocardia Asteroides in the Normal Rabbit

JAMES L. McCARTHY, M.D.; ROSCOE J. KENNEDY, M.D., and JOHN B. HAZARD, M.D., Cleveland

Intraocular infection with Nocardia asteroides has not been reported in various extensive reviews of and experiments in ocular mycology,[1-5] but we believe that it is important to understand the ocular pathologic changes caused by infection with this fungus, because of its similarity both morphologically and pathologically to Mycobacterium tuberculosis.[6] Also, because fungous infections of the eye appear to be increasing in incidence as a result of the widespread use of topical antibiotics and corticosteroids.[7-9] It has been estimated that 5% of all patients in tuberculosis hospitals have nocardiosis that mistakenly has been diagnosed as tuberculosis.[10]

The purpose of this paper is to present the intraocular pathologic findings in the normal rabbit after experimental infection of the eyes with N. asteroides.

Nocard,[11] in 1888, isolated and described the species Nocardia farcineux which caused "la maladie des boeufs de la Guadeloupe," a lymphatic and visceral disease of oxen (farcin du boeuf). In 1891, Eppinger[12] described Cladothrix asteroides isolated from a cerebral abscess in a glass-grinder who had pseudotuberculosis. The naming and classification of this fungus was unsettled: It was called Nocardia, Cladothrix, Streptothrix, or Proactinomyces. In 1943, along with the genera Mycobacterium, Actinomyces, Streptomyces, and Micromonospora, it was definitely placed[13] in the order Actinomycetales.

The general manifestations of nocardiosis are (1) mycetoma, a localized unilateral swelling, usually in an extremity; (2) pulmonary changes, resembling those of tuberculosis, and (3) systemic changes, pulmonary in origin, with generalized metastasis.[10] In nine cases, ocular manifestations of nocardiosis were limited to the cornea and conjunctiva.[14-22]

N. asteroides grows well on Sabouraud's glucose agar or blood-glucose agar; the superficial colonies are yellowish. Microscopically the organism comprises branched, slender filaments or rods of an average diameter of from 0.5$\mu$ to 1.0$\mu$. There are no club forms such as those that occur in Actinomyces. As the colonies get older the mycelium assumes the appearance of bacterium-like granules, short rods, or coccoid forms. No spores, aerial mycelium, or spirals are formed. The cycle of development lasts from two to seven days, and multiplication is by fission and lateral budding. The organism is Gram-positive, usually acid-fast, immotile, aerobic, and diastatic. It can utilize paraffin, phenol, and m-cresol as sources of energy. Other biochemic characteristics distinguish it from the remaining 44 species of the genus.[23] Usually found in the soil, its distribution is world-wide. Infections may occur from inhaling infected material or from contamination after an injury.

Our study does not represent the first experimental attempt to inject fungi into the eyes of experimental animals. Stoewer[24] attempted, without success, to grow on rab-

Submitted for publication Feb. 23, 1959.

Presented at the meeting of The Chicago Ophthalmological Society on May 19, 1958.

Dr. McCarthy now is a Resident in the Department of Ophthalmology, Cook County Hospital, Chicago.

From the Departments of Ophthalmology and of Anatomic Pathology, The Cleveland Clinic Foundation, and The Frank E. Bunts Educational Institute.

bit's cornea a species of fungus (rose mold) isolated from a human who had keratitis, although the fungus grew when it was inoculated into the rabbit's anterior chamber and vitreous. Jadassohn and Rehsteiner [25] injected different strains of fungi (not Nocardia) into the corneas and lenses of guinea pigs and rabbits. Of the four strains tested only Achorion schoenleini was sustained by the test animals. Day [26] injected Histoplasma capsulatum into the anterior ocular chambers of rabbits and produced a granulomatous anterior uveitis, the course of which apparently was self-limited. Ponfick [27] inoculated Actinomycosis into the anterior chamber of an experimental animal and produced a slight iritis.

## Method of Study

The fungus was isolated from a cerebral abscess of a white man and was identified as N. asteroides in the Department of Clinical Pathology of the Cleveland Clinic. The material used for this study was cultured from the mother colony in May, 1957. The superficial colonies were light yellow and of hard consistency.

Six adult, white, male rabbits were used. Under general anesthesia and sterile conditions a small colony of N. asteroides was implanted into the anterior chamber of each right eye and beneath the conjunctiva at the upper fornix of each left eye. Incisions with a Von Graefe knife were made at the limbus from the 11 o'clock to the 1 o'clock positions to facilitate implantation into the right eyes. In each of two of these eyes the incision was closed with a single absorbable surgical (gut) suture; the remaining four incisions were permitted to heal without suturing. After subconjunctival implantation into the left eyes, the incisions were allowed to heal spontaneously. Each eye was treated with prednisolone 21-phosphate-neomycin sulfate (Neo-Hydeltrasol) ointment once daily for one week.

Four rabbits died, presumably of the disease, one each on the 8th, the 15th, the 18th, and the 25th postimplantation days. The remaining two animals were killed on the 22d and the 44th postimplantation days. A complete necropsy was performed on the animal that died on the eighth postimplantation day. The enucleated eyes were fixed in formalin and sagittally sectioned in paraffin, after which they were stained with hematoxylin and eosin, Verhoeff's stain, and the Gridley [28] stain. The Gridley stain is a modified periodic acid-Schiff reaction (PAS) in which peracetic acid is used instead of periodic acid as an oxidizing agent; hyphae and spores are stained red, and most of the other elements are only faintly tinted.

## Results

The N. asteroides produced lesions in four of the six anterior chambers (right eyes) and in three of the six subconjunctival areas (left eyes) (Table). In each of the four affected anterior chambers there was a progressive enlargement of tan nodules after subsidence of the initial inflammatory

*Tabulation of Results*

| Rabbit No. | Postimplantation Day That Eyes Were Enucleated | Occurrence of Lesion at Site of Implantation | | Occurrence of Other Ocular Lesions |
|---|---|---|---|---|
| | | Anterior Chamber (Right Eye) | Subconjunctivally (Left Eye) | |
| 1 | 8th (died) | + | 0 | 0 |
| 2 | 15th (died) | 0 | 0 | 0 |
| 3 | 18th (died) | 0 | + | 0 |
| 4 | 22d (killed) | + | + | Subretinal exudate in right eye, choroidal hyperemia |
| 5 | 25th (died) | + | + | Fungus seen in cornea and filtration angle of left eye (also lacrimal gland) |
| 6 | 44th (killed) | + | 0 | Subretinal exudate in right eye |

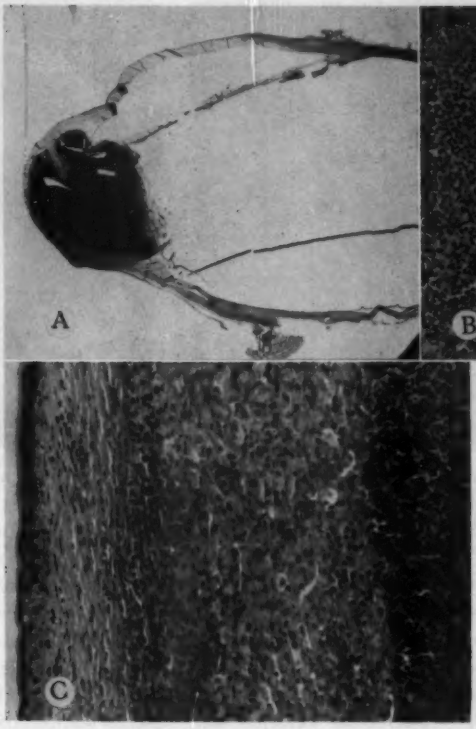



Fig. 1.—Section of the right eye 22 days after implantation of N. asteroides into the anterior chamber. *A*, mass of inflammatory tissue occupying part of the anterior chamber. Small patches of necrosis can be seen throughout the lesion. There is a focal area of interstitial keratitis, but the iris and ciliary body appear free of any appreciable reaction. Hematoxylin and eosin; reduced 25% from mag. × 6. *B*, high-power view showing area of necrosis (microabscess) surrounded by lymphocytes. Hematoxylin and eosin; reduced 25% from mag. × 240. *C*, high-power view showing wall of granuloma containing lymphocytes, epithelioid cells, and fibrous tissue. Cornea also can be seen. Hematoxylin and eosin; reduced 25% from mag. × 240.

reaction of the surgical procedure. Small vessels coursed over these nodules, and the associated inflammatory reaction was slight. The cornea adjacent to these nodules had deep vascularization and was cloudy, although it remained clear in the uninvolved portions of the anterior chamber. Otherwise there was minimal redness of these eyes. No nodules were seen on the iris in the clear areas of the anterior chamber. The three subconjunctival masses of the affected left eyes were light orange, and each

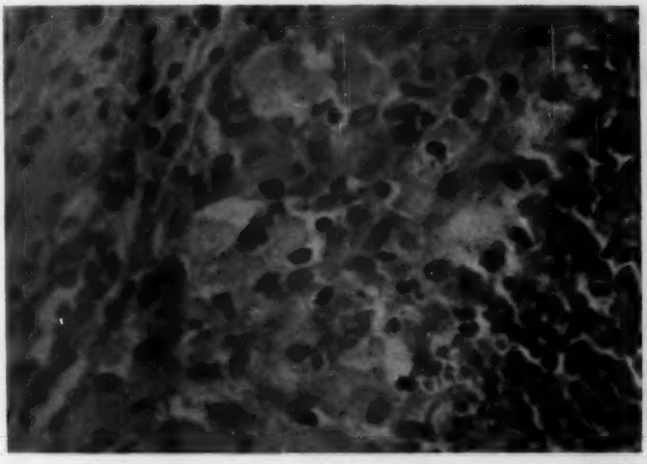


Fig. 2.—Section of the right eye 22 days after implantation of N. asteroides into the anterior chamber. High-power view showing lymphocytes, surrounded by epithelioid cells, in turn surrounded by a thin fibrous wall about which can be seen plasma cells. Note the absence of visible hyphae, giant cells, and calcium deposits. Hematoxylin and eosin; reduced about 40% from mag. × 420.

Fig. 3.—Section of the right eye 22 days after implantation of N. asteroides into the anterior chamber. There are subretinal exudates, folds in the retina which reveal areas of retinitis and retinal necrosis, and choroidal hyperemia. Hematoxylin and eosin; reduced about 40% from mag. × 60.

had small vessels coursing over them; each mass became no larger than a pea. There was no apparent involvement of the intraocular structures of these eyes.

The histopathologic findings at the areas of implantation in the involved right eyes were fairly constant, revealing dark-staining inflammatory tissue in the anterior chamber (Fig. 1*A*). Small patches of necrosis (microabscesses) were present, usually surrounded by a thick ring of lymphocytes (Fig. 1*B*). A small rim of epithelioid tissue enveloped the greater mass of lymphocytes, and surrounding this was a thin fibrous wall (Figs. 1*C* and 2). There were no giant cells, calcification, or spores.

These findings are consistent with the diagnosis of granuloma with microabscesses. Secondary intraocular changes observed in these eyes (anterior chamber implantation) presumably resulted from the liberation of toxins, the release of organisms into vessels and into the surrounding tissues, and the invasion and displacement of surrounding ocular structures (Fig. 3). These included interstitial keratitis and vascularization of the cornea (Fig. 1*A*), lymphocytic infiltration into the anterior chamber angle, edema of the iris and the ciliary body, and bladder-cell formation at the equator of the lens. Hyperemia of the choroid and subretinal exudates was seen in two eyes; however,

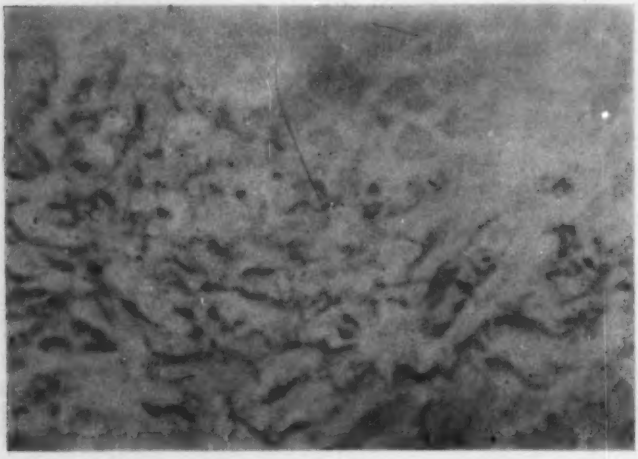


Fig. 4.—Section of the right eye 22 days after implantation of N. asteroides into the anterior chamber. There is a mycelium of curved, bacillary forms of the fungus with minimal branching. These are near the outer wall of the granuloma and stain faintly. Gridley stain; reduced about 40% from mag. × 420.

Fig. 5.—Section of the right eye 22 days after implantation of N. asteroides into the anterior chamber. There is a subretinal exudate with a fine mycelium of faintly staining bacillary forms. This demonstrates posterior spread of the organism. Acid-fast stain; reduced about 40% from mag. × 285.

granulomatous uveitis was not observed. The Gridley stain revealed that the hyphae were most dense near the outer wall of the granuloma in the anterior chamber, where a mycelium of minimally branching filaments could be seen (Fig. 4). Small rods and granules were seen at the outer rim of the microabscesses. The thick ring of lymphocytes appeared to be free from hyphae. Acid-fastness of the fungi in the anterior chamber was minimal or absent; however, as observed in the exudates beneath the retina, this property appeared more intense (Fig. 5). In one involved right eye (22 days postimplantation into the anterior chamber) the fungus was seen in the episcleral tissue. The inflammatory reaction was minimal, and the fungus in these areas existed as nonbranching bacillary forms (Fig. 6). This demonstrates the ability of the fungus to spread locally.

The involved eyes with subconjunctival implants revealed essentially the same type of lesions as that seen in the anterior chambers of the right eyes. A large epibulbar mass of inflammatory tissue consisting of granulomas was observed. Small patches of necrosis were scattered throughout the lesion (Figs. 6 and 7). More formation of fibrous tissue was evident, and

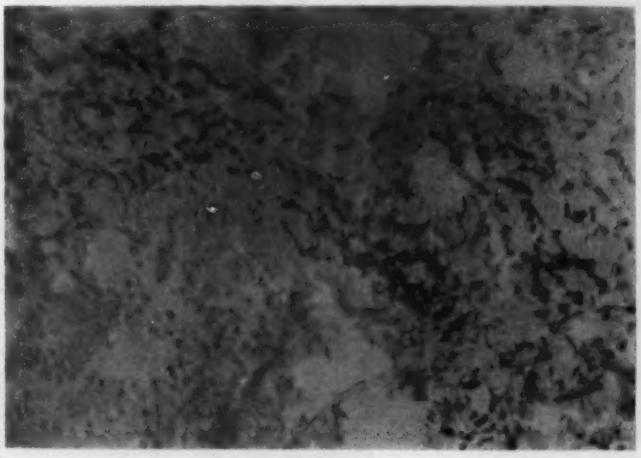


Fig. 6.—Section of the right eye 22 days after implantation of N. asteroides into the anterior chamber. There are fungi in the episcleral tissues demonstrating local spread of the fungus. Gridley stain; reduced about 40% from mag. × 450.

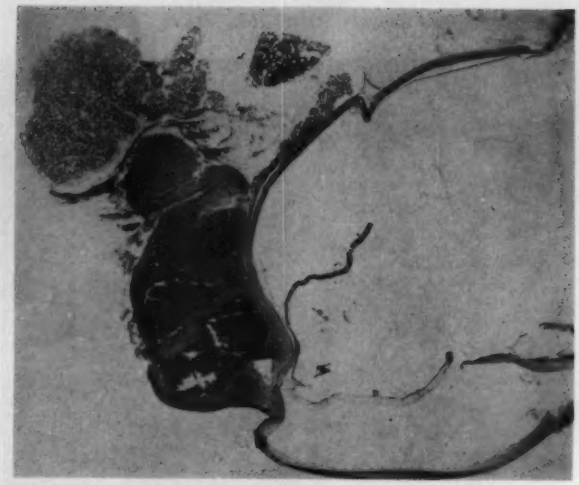


Fig. 7.—Section of the left eye 25 days after subconjunctival implantation of N. asteroides. There is an epibulbar mass of inflammatory tissue in which one can see five granulomas with necrotic patches. Hematoxylin and eosin; × 6.

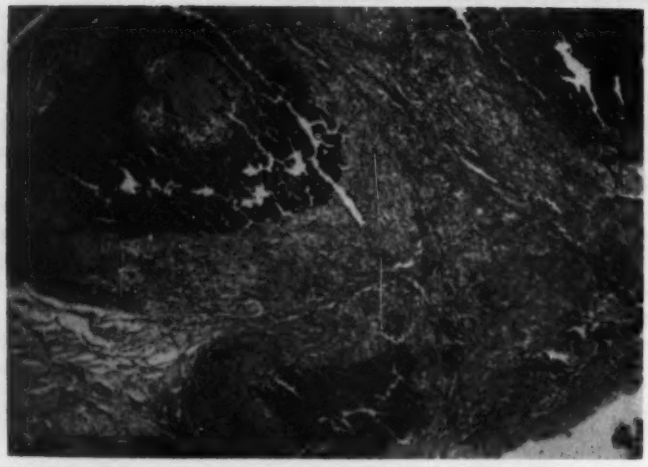


Fig. 8.—Section of the left eye 22 days after subconjunctival implantation of N. asteroides. Three epibulbar granulomas are seen, one with a necrotic patch. Hematoxylin and eosin; reduced about 40% from mag. × 30.

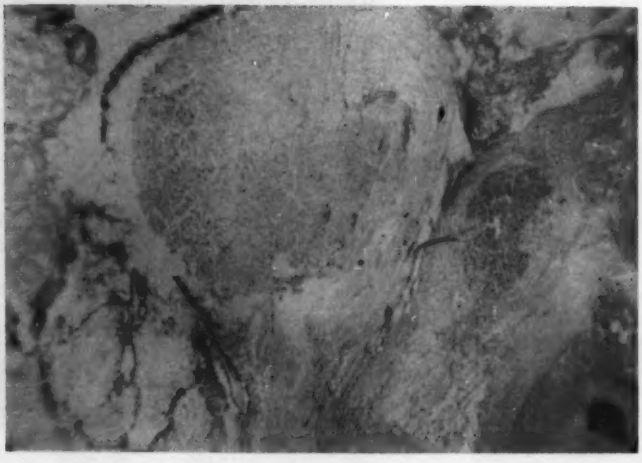


Fig. 9.—Section of the left eye 22 days after subconjunctival implantation of N. asteroides. Stained fungi are seen adjoining part of a granuloma. Gridley stain; reduced about 40% from mag. × 29.

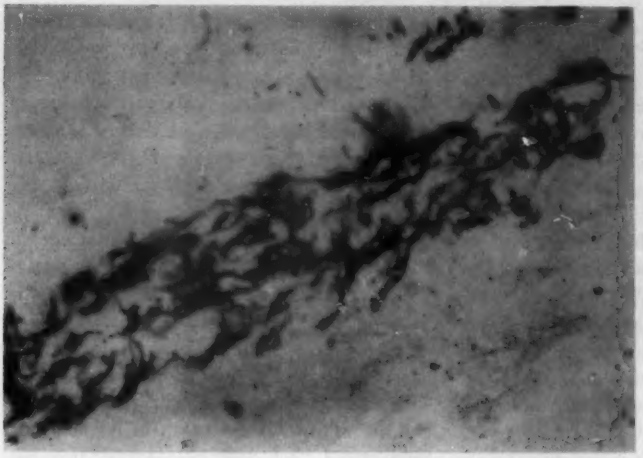


Fig. 10.—Section of the left eye 25 days after subconjunctival implantation of N. asteroides. An intensely staining mycelium of branching forms of the fungus is seen adjoining the wall of a granuloma. Gridley stain; reduced about 40% from mag. × 420.

formation of epithelioid cells was not so conspicuous. The Gridley stain revealed the fungus arranged in a sheet-like manner around the outer wall of the epibulbar mass and in loose areolar tissue adjoining the lesion (Figs. 8 and 9). Branching tendencies of the fungus were more conspicuous and the staining was more intense than in the anterior chambers of the affected right eyes (Fig. 10). In one involved eye the fungus was about the wall of and in the lumen of an artery (Fig. 11). No secondary intraocular pathologic changes occurred in these eyes, though hyphae and rod forms were regularly seen in the scleral and episcleral tissues. In one involved eye, hyphae were in the cornea, the lacrimal gland, and the filtration angle. The acid-fast reaction of the fungus in those eyes was weak.

Necropsy of the rabbit that died on the eighth postimplantation day revealed changes in the liver and other viscera indicative of toxicity.

## Comment

The experience of others [6] suggests that N. asteroides has a variable pathogenicity and often produces only a foreign-body reaction; however, in our study the fungus

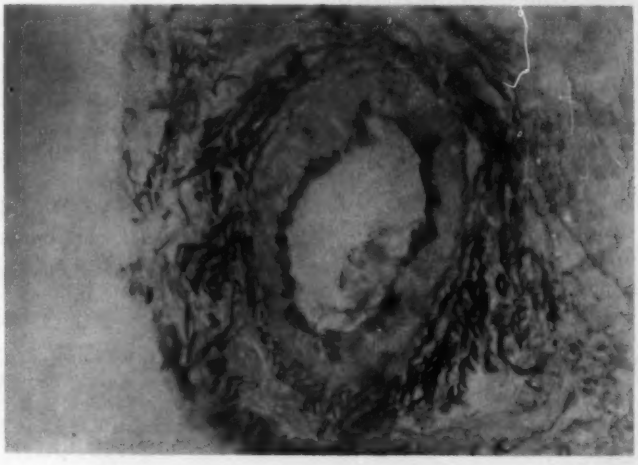


Fig. 11.—High-power view of Figure 9, showing bacillary forms of the fungus about an artery. Faintly staining fungus seen in the lumen. Note that the elastic tissue of the wall of the vessel stains intensely. Gridley stain; reduced about 40% from mag. × 370.

produced lesions in 58% of infected eyes. The characteristic ocular lesion is an enlarging granuloma with patches of microabscesses. In two eyes the occurrence of a granuloma in the anterior segment was followed by the formation of an exudative lesion in the posterior segment, namely, by a subretinal exudate and retinitis. The uveal tissue of the rabbit seems to be weakly responsive to N. asteroides implanted as it was in this experiment. Hyperemia of the choroid and edema of the iris and ciliary body occurred in only one eye. The expanding granuloma displaced and eroded the anterior uveal tract and lens, but no distant granulomatous formation was seen. The spontaneously occurring lesion may be different from that produced experimentally.

It is of interest that the spread of the fungus to such sites as the episcleral tissues, the lacrimal gland, and the filtration angle was accompanied by little if any inflammatory reaction. From this study have emerged two facts that require emphasis. Firstly, the pathologic changes observed are not similar to those of chronic tuberculous uveitis but are more akin to those of conglomerate tubercle, and the granuloma of N. asteroides appears to be more purulent than that of M. tuberculosis. Secondly, N. asteroides is not seen in the sections of tissue stained with hematoxylin and eosin; special histochemical stains are necessary for there to be recognition. Care must be taken in interpreting the results of the Gridley stain, because it also stains elastic tissue, and this property may lead to erroneous diagnoses.

Two cases of infection of the intraocular structures reported to result from Actinomyces may have resulted from N. asteroides. Müller,[29] in 1903, reported a case in which a 22-year-old man had chronic tuberculosis and small solitary nodules of the posterior segment of each eye. At necropsy the choroid was normal, but the involved retina contained nodules composed of epithelioid cells. No bacteria or fungi were seen in the sections. Fuchs,[30] in 1920, reported the case of a 65-year-old man in whom iridocyclitis developed six months after extraction of a cataract. One and one-half years postoperatively the eye was enucleated; in the ciliary body was a large nodule in the center of which was a necrotic mass containing star-shaped formations.

A definitive diagnosis of N. asteroides as the etiologic agent of fungal infections of the eye cannot be made on the basis of histologic examination alone. This organism is pleomorphic; in an infected eye, there can be branched mycelium; single, long, slender filaments; small rods; coccoid forms, and granules. Therefore, the organism must be isolated and morphologically and biochemically identified for the final diagnosis.

## Summary

The primary lesion following implantation of Nocardia asteroides into the anterior chamber or beneath the conjunctiva of the eye of a rabbit is a granuloma with patches of microabscesses. Granulomas in the anterior chamber may cause other intraocular lesions, such as subretinal exudates and retinitis. In our study the uveal tract was weakly reactive to the organism. Special histochemical stains are necessary to demonstrate the organism in tissue section. N. asteroides can reach the filtration angle from the subconjunctiva, can metastasize to the posterior segment from the anterior chamber, and can be carried extraocularly from the anterior chamber. Although the pathologic changes caused by infection with Mycobacterium and by Nocardia may be similar in other parts of the body, in the eye they appear to be similar only insofar as the lesion of Nocardia resembles somewhat a conglomerate tubercle.

Cleveland Clinic, 2020 E. 93d St. (6).

## REFERENCES

1. Rychener, R. O.: Intra-Ocular Mycosis, Tr. Am. Ophth. Soc. 31:477-496, 1933.

2. Gifford, S. R.: Diseases of Eye and Adnexa Due to Fungi and Higher Bacteria, Arch. Ophth. 57:224-237 (May) 1928.

3. Birge, H. L.: Ocular Aspects of Mycotic Infection, A. M. A. Arch. Ophth. 47:354-382 (March) 1952.

4. Fazakas, S.: Zusammenfassender Bericht über meine ophthalmologischen Pilzuntersuchungen, Ophthalmologica 126:91-109 (Aug.) 1953.

5. Cogan, D. G.: Endogenous Intraocular Fungous Infection: Report of a Case, Arch. Ophth. 42:666-682 (Nov.) 1949.

6. Drake, C. H., and Henrici, A. T.: Nocardia Asteroides: Its Pathogenicity and Allergic Properties, Am. Rev. Tuberc. 48:184-198 (Sept.) 1943.

7. Ley, A. P., and Sanders, T. E.: Fungus Keratitis: Report of 3 Cases, A. M. A. Arch. Ophth. 56:257-264 (Aug.) 1956.

8. Ley, A. P.: Experimental Fungus Infections of the Cornea: A Preliminary Report, Am. J. Ophth. 42:59-71 (Oct., Pt. 2) 1956.

9. Zimmerman, L. E., and Gibson, G. G.: Clinical Pathologic Conference, Am. J. Ophth. 45: 826-835 (June) 1958.

10. McQuown, A. L.: Actinomycosis and Nocardiosis, Am. J. Clin. Path. 25:2-13 (Jan.) 1955.

11. Nocard, M. E.: Note sur la maladie des bœufs de la Guadeloupe; connue sous le nom de farcin, Ann. Inst. Pasteur 2:293-302, 1888.

12. Eppinger, H.: Über eine neue, pathogene Cladothrix und eine durch sie hervorgerufene Pseudotuberculosis (cladothrichica), Beitr. path. Anat. 9:287-328, 1891.

13. Waksman, S. A., and Henrici, A. T.: Nomenclature and Classification of the Actinomycetes, J. Bact. 46:337-341 (Oct.) 1943.

14. Schardt, W. M.; Unsworth, A. C., and Hayes, C. V.: Corneal Ulcer Due to Nocardia Asteroides, Am. J. Ophth. 42:303-306 (Aug.) 1956.

15. Benedict, W. L., and Iverson, H. A.: Chronic Keratoconjunctivitis Associated with Nocardia, Arch. Ophth. 32:89-92 (Aug.) 1944.

16. Bruce, G. M., and Locatcher-Khorazo, D.: Actinomyces: Recovery of the Streptothrix in Case of Superficial Punctate Keratitis, Arch. Ophth. 27:294-298 (Feb.) 1942.

17. Bakly: Three Cases of Streptothrix Infection of the Conjunctiva, Tr. Ophth. Soc. U. Kingdom 41:521-525, 1921.

18. May, C. H., in discussion of Crigler, L. W.: Report of the Proceedings of the Section on Ophthalmology of the New York Academy of Medicine, Arch. Ophth. 46:164-174, 1917.

19. Sicardi, J. A.; Regules, U., and Talice, R. V.: Un Cas intéressant d'actinomycose conjonctiva-sclérale d'origine tramatique, Ann. parasitol. 14:171-176 (March) 1936.

20. Thies, O.: Aktinomykose des Sehorgans, Klin. Monatsbl. Augenh. 86:55-58 (Jan.) 1931.

21. Knapp, A., and Dwyer, J. G.: Acute Streptothrix Infection of Conjunctiva, Arch. Ophth. 47:497-499, 1918.

22. Liégard, and Landrieu: Un Cas de mycose conjonctivale, Ann. ocul. 146:418-426, 1911.

23. Breed, R. S.; Murray, E. G. D., and Smith, N. R.: Bergey's Manual of Determinative Bacteriology, Ed. 7, Baltimore, The Williams & Wilkins Company, 1957.

24. Stoewer: Über die Wirkung pathogener Hefen am Kaninchenauge, Arch. Ophth. 48:178-191, 1899.

25. Jadassohn, W., and Rehsteiner, K.: Experimentelle Hyphomyceteninfektionen am Auge, Klin. Wchnschr. 10:308-310 (Feb. 14) 1931.

26. Day, R.: Experimental Ocular Histoplasmosis, Am. J. Ophth. 32:1317-1330 (Oct.) 1949.

27. Ponfick, cited by Duke-Elder, S. W.: Text-Book of Ophthalmology: Vol. 3. Diseases of the Inner Eye, St. Louis, The C. V. Mosby Company, 1947, pp. 2367-2368.

28. Gridley, M. F.: A Stain for Fungi in Tissue Sections, Am. J. Clin. Path. 23:303-307 (March) 1953.

29. Müller, L.: Über Veränderungen im Augenhintergrunde bei miliarer Aktinomykose, Klin. Monatsbl. Augenh. 41:236-247, 1903.

30. Fuchs, E.: Ein Fall intraokulärer Aktinomykose, von Graefes Arch. Ophth. 101:24-31, 1920.

# Effects of "Invisible" Lens Aberrations

*A Clinical Experiment*

**MURRAY F. McCASLIN, M.D., Pittsburgh**

This is the report of an experiment conducted in November, 1958, in the Department of Ophthalmology of Falk Clinic, University of Pittsburgh School of Medicine.

The purpose of the experiment was to determine what percentage of refracted patients could detect any difference in their wearing of genuinely first-quality lenses versus their wearing of lenses of substandard quality, or "second quality."

Because a lens may be pronounced substandard, or second quality, for any one or more of several reasons (weak or strong in power, malpositioned optical center or axis, scratches, incomplete polish, bubbles, aberration due to striae, aberration due to "invisible" grooves in one or both surfaces of the lens), the one factor tested in the subject experiment was that of aberration due to "invisible" grooves on the concave surface of the glass lenses. Except for that one factor, the lenses used in the experiment were otherwise perfect.

Submitted for publication Jan. 14, 1959.

Professor of Ophthalmology, Chairman of the Department, University of Pittsburgh School of Medicine.

The "invisible" grooves, an aberration which escapes detection by the lensometer or vertometer, are easily made visible by projecting the light of a Sylvania C-100W lamp through the lens upon a flat white screen. The C-100W lamp is a point-source of light whereby 100 watts of light energy will emanate from a source no larger than 2 mm.

A perfect lens (free of aberrations) shows on the screen an even shading over the entire area of the lens, as in Figure 1.

The so-called "invisible" grooves in a lens surface take several forms or designs, as shown in Figures 2, 3, and 4, which are unretouched photographs of actual substandard lenses taken from the U. S. domestic lens market.

Nearly all such lenses pass the lensometer or vertometer, as do the pictured lenses in Figures 3 and 4.

The aberration studied in the subject experiment was caused by intentionally produced circular grooves of the type shown in Figure 4.

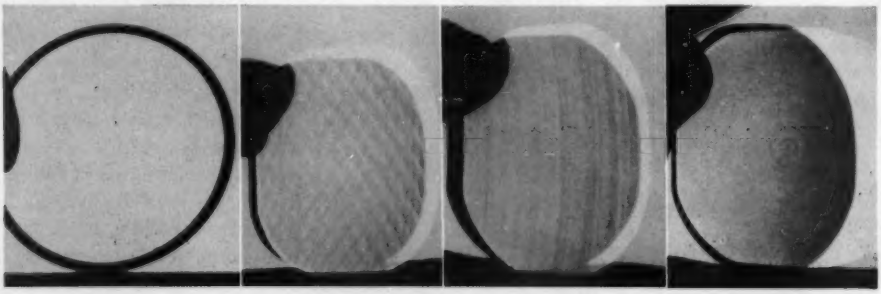


Figure 1 Figure 2 Figure 3 Figure 4

### Modus Operandi

Thirteen consecutive nonpresbyopic patients were used without regard to age, sex, race, or type of prescription, other than that all thirteen patients were to receive single-vision lenses, so that no bifocal nor trifocal problems would be introduced.

Each patient was given two pairs of glasses, identical as to frame, size and shape of lens, prescription, corrected curves, P. D., and adjustment of lenses vertically and in vertex distance.

One pair of lenses was perfect. The other pair of identical lenses (same corrected curves) had intentionally produced circular grooves on their posterior surfaces but otherwise were perfect and passed the lensometer test.

At no time was the patient told that there was any difference in quality of the lenses. There was no identifying mark on either pair of glasses. The dispensing optician at Falk Clinic was not told which pair was which.

The dispensing optician gave each patient the same instructions, which had been typed for him to read aloud to each patient in order that he could not influence the patient's decision.

Briefly, the dispenser told each patient, "Mrs. Jones, every once in a while somebody comes up with a different idea for grinding lenses. The only way to find out if an idea is any good is to try it. So we've taken the liberty of making two pairs of glasses for you, both of them identical in every respect, same frame, same power of lens, but one pair is ground with the conventional grinding, and one pair ground the other way. Please take this piece of red scotch tape and put it on one of the earpieces of either one of these two pairs. It makes no difference which pair you put it on. Now, we want you to wear one pair today, tomorrow wear the other pair, the third day switch back to the first pair, and alternate wearing them every other day for a week or ten days. Then come back and tell us if you see any difference at all or whether they are both the same. If you do see any difference, tell us which pair is better, or tell us if they are both the same."

After the 13 patients had returned and made their reports, then the lenses were subjected to the Sylvania C-100W test to learn which pair was the substandard, or second-quality, pair.

### Results

These are the 13 prescriptions and the reports of the 13 patients tested.

CASE 1.—Caucasian, female: Rx O. D. +0.25 +0.25×90; O. S. +0.25 +0.25×90.

Patient's Comment: "I felt a tiny bit dizzy with this pair [the second quality], but it seemed all right for reading."

CASE 2.—Negro, male: Rx O. D. −0.50 sph.; O. S. −0.75 sph.

Patient's Comment: "There's no difference at all."

CASE 3.—Caucasian, female: Rx O. D. −0.25 −0.25×90; O. S. −0.75 −0.75×85.

Patient's Comment: "No difference in either pair. I see the same with both."

CASE 4.—Negro, female: Rx O. D. +0.75 +1.75×105; O. S. +0.75 +2.00 ×85.

Patient's Comment: "After an hour or more, this pair [the second quality] is not so good for reading . . . it's almost as though I was reading through my eyelashes."

CASE 5.—Negro, female: Rx O. D. −1.75 −0.50×180; O. S. −2.00 sph.

Patient's Comment: "They look the same to me. It may be that I can see just a tiny bit farther at a great distance with these [the second quality], but I'm not sure."

CASE 6.—Caucasian, female: Rx O. D. +0.50 sph.; O. S. +0.25 +0.50×60.

Patient's Comment: "I see no difference."

CASE 7.—Caucasian, male: Rx O. D. −1.00 −0.25×180; O. S. Plano (no vision).

Patient's Comment: "There seems less glare with this one [the first quality]. My eye seemed to tire more easily with this one [the second quality]."

CASE 8.—Caucasian, female: Rx O. D. +3.00 sph.; O. S. +3.00 +1.00×90.

Patient's Comment: "This pair [the second quality] makes my eyes a little bit tired. I can see the details of that brick wall across the street a little bit better with this pair [the first quality]."

CASE 9.—Caucasian, male: Rx O. D. +2.75 +0.50×80; O. S. +3.00 sph.

Patient's Comment: "Can't see any difference."

CASE 10.—Negro, male: Rx O. D. −3.25 −0.25×45; O. S. −3.00 sph.

Patient's Comment: "They both seem the same."

CASE 11.—Caucasian, female: Rx O. D. −0.25 −0.50×180; O. S. −0.75 −0.75×180.

Patient's Comment: "They seem exactly the same to me."

CASE 12.—Negro, female: Rx O. D. −2.00 −1.75×90; O. S. −0.50 −0.75×90.

Patient's Comment: "I can't tell any difference."

CASE 13.—Caucasian, female: Rx O. D. +0.75 −1.00×35; O. S. +0.75 −1.00×160.

Patient's Comment: "This pair [the first quality] seemed better, especially the left eye. The other pair [the second quality] seemed sort of watery, glare-like, in the left eye."

In summary, 7 of the 13 could tell no difference between the perfect lenses and the substandard, or second-quality, lenses.

One of the thirteen stated she doubted that there was any difference but that, if there was, it might be that with one pair she could "see just a tiny bit farther at a great distance." That pair was the second-quality pair. No actual difference in visual acuity was measurable.

Five of the thirteen were definite in their rejection of the second-quality lenses, although usually vague and indefinite in describing their reasons for rejection. "I don't know, but this pair seems to bother me somehow," might be said to be the general theme of the five who rejected the second-quality lenses.

## Conclusions

An experiment comprising only 13 patients, even though 13 consecutive, unselected patients, usually does not justify any hard and fast conclusions.

Such an experiment so conducted rapidly runs into money, which precluded a test covering 100 more patients.

However, as a result of the subject experiment, the following conclusions seem rather safe:

1. There probably is no injury, temporary or permanent, to the eye in wearing a second-quality lens.

2. There is a certain percentage of patients whose visual acuity zonally will be impaired by, or who will be annoyed by, wearing a second-quality lens possessing "invisible" surface grooves which can be revealed with the Sylvania C-100W lamp.

3. Sensitiveness to such second-quality lenses bears no relation to the type of prescription, nor to the age or sex or race of the patient.

4. Unless a patient had one perfect pair of lenses with which to compare the second-quality pair, most patients probably would wear the second-quality pair and silently put up with any annoyance, assuming that such annoyance was part of the penalty of wearing glasses.

5. As long as any percentage of patients can detect a difference, even an indefinite difference, when comparing genuinely first-quality lenses with second-quality lenses, the ophthalmologist would seem to be justified in insisting that the dispensing optician use on each prescription only lenses individually proved with the Sylvania C-100W lamp to be genuinely first quality.

## Critical Comment

The "C-100W concentrated arc test" for first-quality lens surfaces is today a routine step in the lens-inspection procedure of some wholesale optical houses or lens-grind-

ing laboratories and by some opticians throughout the country. In some areas the C-100W test is used by such houses 100% but in some areas not at all.

The code of ethics of The Guild of Prescription Opticians of America sanctions the use of only first-quality lenses but, to date, any written specifications for first quality have not included the C-100W test for rejection of "seconds" and, to date, have depended solely on the rather tolerant neutralizing instrument to disclose any aberration.

Lens-grinding houses which do not routinely use the C-100W test may sincerely feel they are offering only first-quality lenses, whereas some of their lenses actually may be of inferior quality, or, as we term in this experiment, "second quality."

### Recommendation

It may be in order, then, to suggest that the today's specifications for a first-quality lens be amended to include the need for passing the "C-100W concentrated arc test" before measuring for power with the lensometer.

Department of Ophthalmology, Eye and Ear Hospital (13).

# The Use of Dexamethasone in Ophthalmologic Steroid Therapy

*A Preliminary Report*

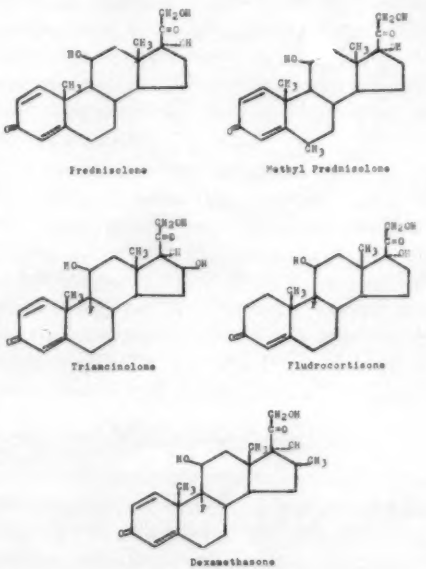
**RAY H. NIELSEN, M.D., North Hollywood, Calif.**

As experience has taught us, the biologic properties of cortisone and hydrocortisone may be altered, both favorably and unfavorably, through changes in their basic structure. The unending search to build better clinical properties into adrenocortical steroids appears to have moved an important step ahead with the synthesis of dexamethasone, achieved by addition of a methyl radical at carbon 16 and a fluorine atom at carbon 9 of the prednisolone structure.[1,2] Preliminary observations indicate that the alteration to produce dexamethasone certainly has resulted in an improved compound with greatly increased milligram activity along with substantially decreased undesirable effects.

Initial studies with dexamethasone revealed that this compound has a milligram activity approximately 8-10 times that of prednisone or prednisolone and 30 times that of cortisone. Certain undesirable effects reported with the hydroxylated steroids (such as triamcinolone) of muscle wasting, increased tendency to ecchymoses, and abnormal weight loss are not associated with dexamethasone, and those undesirable effects seen with prednisone and prednisolone appear to be greatly decreased in incidence. In fact, salt and water retention, diabetogenic activity, and weight gain generally have been absent with the clinical use of dexamethasone. Since this steroid has such a greatly increased therapeutic ratio, as compared to side-effects, I began using dexamethasone where steroids were indicated as soon as it became available for experimental use in the summer of 1958. This paper is a presentation of my experience with this steroid.

Since this steroid has just been introduced into clinical medicine, it might be well to review a few basic facts concerning its nature before proceeding to discuss my own experience with it in a series of cases. It compares to other recent steroids in its chemical structure as shown in the Figure.

Dexamethasone alcohol occurs as a white to cream-white crystal or crystalline powder that has a melting point of about 240 C. It is a synthetic analogue of prednisolone in which a methyl group has been added




Submitted for publication Feb. 10, 1959.

The dexamethasone (Deronil) used in this study was supplied through Harry V. Pifer Jr., M.D., Division of Clinical Research, Schering Corporation, Bloomfield, N. J.

at the carbon 16 position and a fluorine atom at the carbon 9 position. It has been known for several years that the addition of fluorine at the carbon 9 position greatly enhances the anti-inflammatory activity of the resulting compound. This addition, however, also produces marked undesirable side-effects, as in fludrocortisone. Recently it was found that the addition of various groups at carbon 16 reduced the side-effects even though the activity of the compound remained the same. Triamcinolone was the first such altered compound put on the market, but experience has shown that, even though the hydroxyl radical at carbon 16 reduced the well-known steroid side-effects, the addition of this radical produced new side-effects never before seen with any of the steroids. It was a logical step for organic chemists to try other radicals at the carbon 16 position, and when the methyl radical was added the activity of the compound was found to be much greater and the apparent side-effects were much less as compared to the hydroxyl steroid. The methyl group thus reduced the side-effects but allows a much more potent anti-inflammatory action than methyl prednisolone because of the presence of the fluorine atom at the carbon 9 position.

In experimental studies it has been adequately demonstrated that dexamethasone does not produce sodium or water retention in adrenalectomized rats; nor is any potassium loss induced. Again in rats, it produces granuloma inhibition up to 190 times that produced with hydrocortisone. It suppresses corticotropin secretion about 30 times greater than prednisolone. It does not suppress aldosterone production, however, and indeed it failed to suppress normal aldosterone responsiveness to dietary sodium restriction or sodium loss. Dexamethasone produces a definite increase in nitrogen excretion so that a negative nitrogen balance is produced. As soon as the drug is withdrawn, increased retention of nitrogen follows and the patient goes into a positive nitrogen balance. There is also a negative phosphorus and calcium balance while on the drug, which is reversed as soon as the drug is discontinued. Glucose-tolerance tests remain normal with the administration of dexamethasone.

Increased anti-inflammatory potency per se is of no real value in a steroid, but it is a higher therapeutic ratio which is important and is being sought after. What does it matter if the anti-inflammatory potency of a steroid is increased 10 times if then the dosage must be reduced to one-tenth to prevent serious side-effects? The constant search is for a steroid with increased anti-inflammatory potency and having at the same time relatively few if any side-effects. Such a steroid is needed to suppress the inflammatory response in those cases seen by all of us in which there is no response or an inadequate response to the presently available steroid compounds when given in the highest dosage compatible with safety for the patient.

In preliminary studies dexamethasone appears to be a steroid with an increased therapeutic ratio. If this proves to be true it will be of great value in our chronic or unresponsive cases. Because of the apparent increase in therapeutic ratio, I did not use the comparative dosages of currently available steroids in arriving at my beginning dosage level. Instead, I used as evidence for guidance such factors as the duration of the disease, the chronicity of the disease, the response to previous steroids, the clinical appearance of the eye, and the general health of the patient.

Before any patient was placed on this steroid it was determined that no contraindication to its use was present. Absolute contraindications are herpes simplex keratitis, active tuberculosis, active peptic ulcer, a psychosis or severe psychoneurosis, or Cushing's syndrome. Relative contraindications include diabetes, pregnancy, and cardiorenal disease.

I do not agree with the often-expressed idea that the complications of steroid therapy are the worry of the internist. As ophthalmologists we are the ones that should be concerned with the administration of the

steroid, the effects on the eye, and any side-effects the steroid might have on the patient. We are the ones seeing the patient at frequent intervals and are most interested in the patient's welfare. It is we to whom the patient will come with his complaints when a side-effect becomes troublesome. We should be aware of the side-effects of any drug we use and try to recognize them in their incipient phases.

I developed and followed a definite routine with each patient on dexamethasone therapy. Before beginning treatment I ruled out all contraindications and took the patient's weight and blood pressure. In addition, I measured the diameters of the arms and legs at a given point for later comparison. On each subsequent visit I questioned the patient carefully concerning all possible symptomatic side-effects, took his weight and blood pressure, and again measured the diameter of the extremities. While each patient was at the highest dosage level I obtained at least once an ECG, fasting blood sugar, serum sodium level, and serum potassium level, and a 24-hour urine specimen was analyzed to determine the daily urinary loss of calcium, creatine, creatinine, and 17 ketosteroids.

Depending on the factors influencing my choice of dosage given above, I have started patients on a dosage schedule varying from 3.2 mg. to 10 mg. per day. The 10 mg. dexamethasone dosage is the anti-inflammatory equivalent of 80-100 mg. of prednisolone. In spite of this high dosage I have maintained several patients on 10 mg. per day for over six weeks in order to obtain the desired effect on the ocular disease being controlled. This dosage level is very seldom necessary, however, since most ocular diseases responsive to steroids will respond to doses of 4 mg. or less.

## Present Study

I have used dexamethasone for five months to evaluate its value in the treatment of those eye diseases in which it is necessary to suppress inflammation and its sequelae from destroying the functional integrity of the eye. I found it to be especially useful in treating cases of uveitis, where it is important that we maintain a high concentration of an anti-inflammatory agent in the eye at the cellular level. It seems to be the nature of uveitis to heal spontaneously, and this healing is most probably brought about by an increased immunity through fixed tissue antibodies and to some extent by humoral antibodies. A decrease in local hypersensitivity may also be a factor in those cases due to an altered reactivity to a variety of antigens. In the process of healing spontaneously, however, there is exudation, neovascularization, and a variable amount of scarring. Steroids do not interfere with the mobilization of the body defenses to produce healing, but while this is going on, the steroids prevent the formation of permanent obstacles to normal function after the disease has run its course. The potent action of dexamethasone proved to be a greater deterrent to exudation, neovascularization, and scarring than any agent I have yet used. In many cases it reduced the inflammatory process where all previous agents had failed in maximum doses.

I have used dexamethasone to treat 12 cases of uveitis, 2 of which were of the chronic granulomatous type with the other 10 being the acute or chronic nongranulomatous type. Since granulomatous uveitis is noted for its chronicity and poor response to any therapeutic agents, the case histories and record of treatment with dexamethasone follow.

Case 1.—A 45-year-old woman had been under treatment for a chronic granulomatous uveitis of the right eye for three years. A complete diagnostic survey failed to disclose any etiologic factors. Over the years she had been treated with fever therapy and maximum doses of steroids, including prednisolone. The disease did not respond to any form of therapy.

When I first saw her she had a visual acuity of hand movement at 1 ft. with the right

eye. No keratic precipitates or iris nodules were visible. There were Grade 1 cells and flare in the anterior chamber. There was no evidence of a complicated cataract. The vitreous was very hazy, permitting a cloudy view of the fundus. There were disseminated chorioretinal lesions scattered over the entire fundus with many depigmented areas surrounded by a concentration of pigment granules. Many of the lesions looked active, especially nasally. The intraocular pressure was normal.

No contraindications to the use of steroids were found. Her weight and blood pressure were recorded. She was then started on a dosage of 10 mg. dexamethasone daily in divided doses. She was not placed on a low-salt diet, nor was any additional potassium given. Only in this way could a true picture of the electrolyte effects be obtained.

The cells and flare in the anterior chamber disappeared rapidly, and the vitreous haze slowly cleared. Within one month her vision was 20/200 in the right eye and she began to experience some depth perception. The active fundus lesions now showed evidence of definite healing with decreased exudation and increased pigmentation.

Her weight was about the same, and her blood pressure remained constant. Laboratory studies revealed a normal ECG, serum potassium of 3.97 mEq., serum sodium of 142.3 mEq., fasting blood sugar of 72 mg. %, 24-hour urinary calcium excretion of 0.22 gm., 24-hour 17 ketosteroid excretion of 5.4 mg., 24-hour creatine excretion of 372.4 mg., and a 24-hour creatinine excretion of 1.6 gm. All of these values are normal for the laboratory in which they were done, with the exception of an increased urinary creatine excretion and a slightly decreased urinary 17-ketosteroid excretion.

She was just beginning to become Cushingoid after one month, as evidenced by a rounding of her face, and she also began experiencing muscular pains especially near the joints. Therefore, the dosage of dexamethasone was decreased by 0.4 mg. per day. As the dosage was reduced there was continued healing of the fundus lesions. When the dosage reached 2.4 mg. per day an increase in vitreous flare was noted, so the dosage was increased and finally stabilized at 3.2 mg. per day as the lowest dosage without a flare of the disease. She is continuing on 3.2 mg. per day, and the fundus lesions have almost all healed to an inactive state. When there is complete healing she can then be withdrawn from the steroid gradually without the danger of a flare of activity.

CASE 2.—The second case is that of a 38-year-old woman with a localized granulomatous uveitis of the right eye of over one year's duration. A complete diagnostic survey failed to reveal any etiological factors. Over the previous year she had received several courses of fever therapy, courses of all types of antibiotics, vasodilators, and full systemic doses of both hydrocortisone and prednisolone. The lesion did not heal in response to any of these various forms of treatment.

On my first examination I found her vision to be 20/20 14/21 in both eyes. She complained of metamorphopsia and a blind spot in the right eye. This was confirmed by testing with an Amsler grid, which revealed linear distortion. A visual field disclosed a paracentral scotoma in the field of the right eye which was dense to a 35 mm. white test object. There were no keratic precipitates, cells or flare in the anterior chamber, iris nodules, or evidence of a complicated cataract. The intraocular tension was normal. The vitreous was fairly clear, permitting a good view of the fundus. Just inferior to and temporal from the disc was a circular area of choroiditis. The periphery of the lesion was healed, but there was much activity centrally with considerable exudation extending to a point very near the macula.

Ten years previously the patient had typical ulcer symptoms, but no ulcer was ever shown on x-ray. As she has had no symptoms since, it does not constitute a contraindication to steroid therapy. There were no other contraindications, so the pa-

tient was started on 10 mg. dexamethasone daily in divided doses. Her weight, blood pressure, and extremity measurements were taken before the medication was started. She was not placed on a low-sodium diet or given any supplemental potassium. During the first two weeks of therapy, her vitreous became completely clear and the lesion began to change in appearance. The bright sheen over the exudative lesion gradually disappeared, and the surface took on a "harder" look resembling the waxy-looking exudates found in diabetic retinopathy. After two weeks I began lowering the dosage by 0.4 mg. daily until she reached a level of 6 mg. per day. This was continued for six weeks, and during this time the lesion became more pigmented and tended to blend into the pigmented inactive scar surrounding it.

While she was at the level of 6 mg. per day the battery of laboratory tests was obtained. The tests revealed a normal upper gastrointestinal series, normal ECG, fasting blood sugar of 98 mg. %, serum sodium of 136 mEq., serum potassium of 5.6 mEq., 24-hour urinary calcium excretion of 0.14 gm., 24-hour 17-ketosteroid excretion of 8.0 mg., 24-hour creatine excretion of 108 mg., and a 24-hour creatinine excretion of 1.2 gm. All of these values are normal for the laboratory in which they were done.

The 6 mg. daily dexamethasone dosage was continued for one month, and during this time the lesion continued to heal steadily, blending gradually into the inactive lesion surrounding it. After one month the dosage was reduced by 0.4 mg. per day until 1.2 mg. daily was reached. This dose was given daily for a week and then reduced by 0.4 mg. every other day. At no time during the dosage reduction or when dexamethasone was discontinued was there any flare of the lesion or in the vitreous. The lesion has now remained unchanged in appearance for five weeks and seems to be definitely healed.

The 10 cases of nongranulomatous uveitis responded rapidly and well to doses of 3.2-4.0 mg. of dexamethasone. The systemic doses were only necessary for two to three weeks on an average, while topical steroids were continued two weeks after systemic therapy was discontinued. One case of acute nongranulomatous uevitis with much chorioretinal involvement required systemic therapy for two months, however, before the disease was controlled. Another case of nongranulomatous uveitis relapsed three weeks after systemic therapy with dexamethasone was discontinued, so that resumption of systemic therapy was necessary. When the systemic dexamethasone was reduced in dosage the second time, subconjunctival injections of 0.5 cc. of 2.5% prednisolone were instituted. These subconjunctival injections were continued at weekly intervals for one month after systemic dexamethasone was withdrawn. The patient has now been free of any active uveitis for over two months.

In all cases of uveitis with anterior segment involvement, 1% atropine drops were given concomitantly with the steroid therapy. Gordon writes that atropine is not necessary if steroids are being used, for the steroids prevent the formation of synechiae. It is often forgotten, however, that atropine has at least three other favorable actions in cases of anterior segment involvement. By relaxing the ciliary muscle it first relieves pressure on the ciliary arteries and increases the blood flow to the iris; second, its cycloplegic action prevents or releases ciliary spasm and thus reduces the pain accompanying an acute iridocyclitis, and third, atropine decreases the permeability of the blood vessels to protein, resulting in reduced exudation. For these reasons it seems logical to use atropine in all anterior segment involvement.

In addition to uveitis cases, I have used dexamethasone in three cases of episcleritis and one case of scleritis in a rheumatoid arthritis patient. All four cases responded rapidly to 4 mg. daily of dexamethasone, and there has been no relapse on withdrawal of the steroid. Since recurrent scleritis or episcleritis often accompanies rheumatoid arthritis cases, it would be exceptional if the case of scleritis does not recur in the

future. The action of the drug in individual episodes is impressive, however.

Two cases of vernal conjunctivitis responded very well to 3.2 mg. of dexamethasone daily along with topical prednisolone therapy. The papillae melted away completely in two to three weeks, leaving no residual changes. Steroid therapy with such an active agent may prove superior to radiation even in severe cases.

One case of atopic dermatitis of the eyelids cleared completely when dexamethasone was made into a lotion and applied four times daily. The same skin lesion had previously shown no response to either topical prednisolone or topical fludrocortisone.

## Comment

Dexamethasone has proven to be very effective in suppressing inflammation in those cases where it is necessary in ophthalmology. This steroid apparently has an increased therapeutic ratio so that it may be used in larger comparative doses than all previous steroids without danger to the patient. My preliminary clinical series with use of this steroid seems to indicate that when necessary, in resistant and unresponsive cases, it is feasible to use dexamethasone in doses of up to 10 mg. per day. It was not necessary to lower the dosage level in any of the four patients on 10 mg. per day because of serious side-effects. Side-effects occur at this dosage level, but they are not of the severity to necessitate reduction of the daily dose. Complete laboratory studies done on patients at this dosage level disclosed no abnormal findings except in one patient who had an abnormally high 24-hour urinary creatine excretion. The creatine excretion was normal in the other three patients on the same high dosage. There was no reduction in the diameter of extremities in any of the cases treated. It will seldom be necessary in ophthalmology to use over 4 mg. per day of dexamethasone, since this has the equivalent anti-inflammatory activity of 40 mg. of prednisolone.

It was my experience that the only side-effects experienced with a total daily dosage of 4 mg. or less were a mild euphoria, increase in energy, and an increased appetite which sometimes leads to a gain in weight due to excessive caloric intake. In doses between 4-10 mg. some patients experienced nervousness, increased energy, euphoria, dulling of the sense of taste, increased appetite with resultant weight gain, and musculoskeletal pain. All of these symptoms varied a great deal from patient to patient. The most frequent and troublesome complaint was the gain in weight produced by continual overeating in response to the increased appetite. The weight was easily lost through dieting after completion of therapy. Some patients noticed the lack of energy after withdrawal from high doses. Two of these I tided over with methylphenidate (Ritalin), which was gradually withdrawn.

It is important to realize that even in patients on the high 10 mg. dosage there never occurred any edema, hypertension, impairment of carbohydrate tolerance, peptic ulcer, psychosis, or pathologic fracture.

## Summary

A preliminary evaluation was made of the new steroid dexamethasone in 19 cases. Dexamethasone has an anti-inflammatory potency 8-10 times that of prednisolone, making it the most potent steroid in clinical use. Preliminary studies seem to indicate that this steroid has fewer side-effects than any of those now used, even when used in very large doses. Thus, dexamethasone appears to have the property which is so sought after in any steroid, an increased therapeutic ratio.

It is a well-known fact that it takes several years and many thousands of cases to properly evaluate the usefulness and safety of a drug in therapeutics. Therefore, the

information derived from the first few cases on which it is used gives us only a positive or negative impression which with further experience may lead to definite conclusions. From my original impression I am proceeding to evaluate dexamethasone in all types of eye disease and would encourage a general trial of this drug to ascertain its value in our specialty.

12027 Riverside Dr.

## REFERENCES

1. Bunim, J. J., et al.: Arthritis & Rheumatism 1:313, 1958.

2. Boland, E. W.: California Med. 88:417, 1958.

# The Scleral Buckling Procedures

## *IV. Reoperations Following Scleral Bucklings*

I. D. OKAMURA, M.D.; C. L. SCHEPENS, M.D., and R. J. BROCKHURST, M.D., Boston

The first and second articles of this series contain a description of the techniques of scleral buckling when performed as a primary procedure, and the third article deals with difficulties in reoperations following other types of retinal surgery. This article describes techniques used when a reoperation follows a scleral buckling procedure. A more detailed discussion of the indications for procedures used in reoperations will be the subject of our next article.

One of the greatest dangers in reoperating after a diathermy operation and, to less degree, after a scleral resection is that sclera treated with diathermy is edematous, prone to rupture, and adherent to orbital scar tissue. After a scleral buckling, on the other hand, the treated portion of the sclera is folded in and protected by the polyethylene tube. Adhesions between sclera and orbital soft tissues are less dense and easier to dissect. This reduces the danger of accidentally perforating the globe during a reoperation. Another advantage is that the location of the previous buckling is detected by the presence of stained nonabsorbable mattress sutures and of the polyethylene tube. When the latter is deeply buried in the sclera, its position is readily detected by touch with forceps or with a Desmarres scarifier, as it feels harder than sclera. The above reasons explain why reoperations on eyes which were submitted to a previous scleral buckling are generally easier and safer than those following either simple diathermy or most of the scleral resection procedures.

When a reoperation is performed on an eye which has previously been submitted to a scleral buckling, the release of subretinal fluid should be performed with special care. As mentioned in greater detail in a previous publication,[1] it is generally advisable to release the subretinal fluid in the bed of the lamellar scleral resection. In the area chosen for perforation subretinal fluid should be abundant, and the location should be as distant as possible from the retinal breaks. It is, therefore, absolutely essential to examine the fundus carefully with the ophthalmoscope before one decides to perforate. A small knuckle of choroid is exposed by making a scratch incision in the sclera. This incision is preferably done in a meridional direction, and it should be located under a mattress suture. In case of vitreous loss, tying the mattress suture will press the tube against the perforation and close it hermetically. When reoperating, it is generally advisable not to reopen a previous buckle for the sole purpose of releasing the subretinal fluid, as this sometimes leads to rupture of the choroid. It is preferable, therefore, to release the subretinal fluid either in the area of the new lamellar scleral resection or away from the scleral buckling. In the latter case, the location chosen is generally posterior to the buckle (Fig. 1). A meridional scratch incision is made in the sclera until bare choroid is nearly exposed. A 0000 nonabsorbable surgical mattress suture is placed on the lips of the scleral incision. A narrow, blunt spatula is inserted in the scleral incision and pushed gently under the scleral lips,

Submitted for publication Feb. 23, 1959.
Paper 78, Retina Foundation.
This work was supported by the Dazian Foundation.

From the Retina Foundation, Department of Ophthalmology of the Massachusetts Eye and Ear Infirmary and Harvard Medical School.

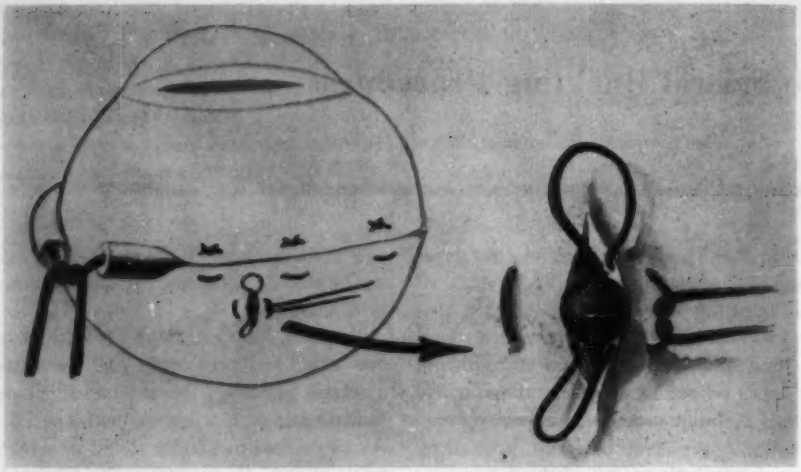


Fig. 1.—Reoperation for the purpose of releasing subretinal fluid and shortening the circling polyethylene tube. The sleeve on the circling tube is slid to one side. The circling suture is cut, removed, and replaced with another suture. A meridional scratch incision is made in the sclera generally posterior to the buckling site. The drawing on the right shows the appearance of the knuckle of choroid obtained after the use of a spatula. Note that no additional diathermy has been used in this case.

in the suprachoroidal space, for 1 or 2 mm. The purpose of this step is to break the remaining scleral fibers and to expose a knuckle of choroid. Perforation of the choroid is then carried out with a fine diathermy needle as previously described.[1] As a rule, no additional diathermy is used around the perforation site. When the subretinal fluid has been released, the mattress suture placed on the lips of the scleral incision is tied. It is essential at least to pull up and lock this suture before the other scleral buckling sutures are pulled up.

When repeating a scleral buckling, it is essential to choose a technique which fits the case; this results in a variety of procedures for reoperations. Several have already been described, such as the trapdoor procedure[1] and the undermining procedure.[2] The reoperations described below fall in two categories as they are aimed either at modifying the existing scleral buckling or at adding another scleral buckling.

### I. Modifications of an Existing Scleral Buckling

The existing scleral buckling may be made more extensive in length, width, or height. Such results may be obtained by one of the following procedures: replacing a partial tube by a circling tube; burying a circling tube in the sclera over its whole circumference; shortening an existing circling tube, thus increasing the height of the buckle, and widening an existing scleral buckling. Finally, more intense diathermy may be applied over the area previously buckled.

*A. Replacing a Partial Tube by a Circling Tube.*—Replacing a partial tube by a circling tube results in a buckle which can be made higher and more permanent. However, in nearly all of these cases the bed of the lamellar scleral resection must also be modified, either in length or width, as described in Sections *B* and *D*. The first step is to expose the area where the partial tube is buried. One end of the circling tube is tapered by stretching it (Fig. 2). The 00 nonabsorbable surgical suture, which is threaded through the tubing before it is tapered, will prevent the end of the tube from flattening. The tapered end is then telescoped into the short tube which is buried in the sclera, and the circling tube is gently pushed into the place occupied by the partial tube.

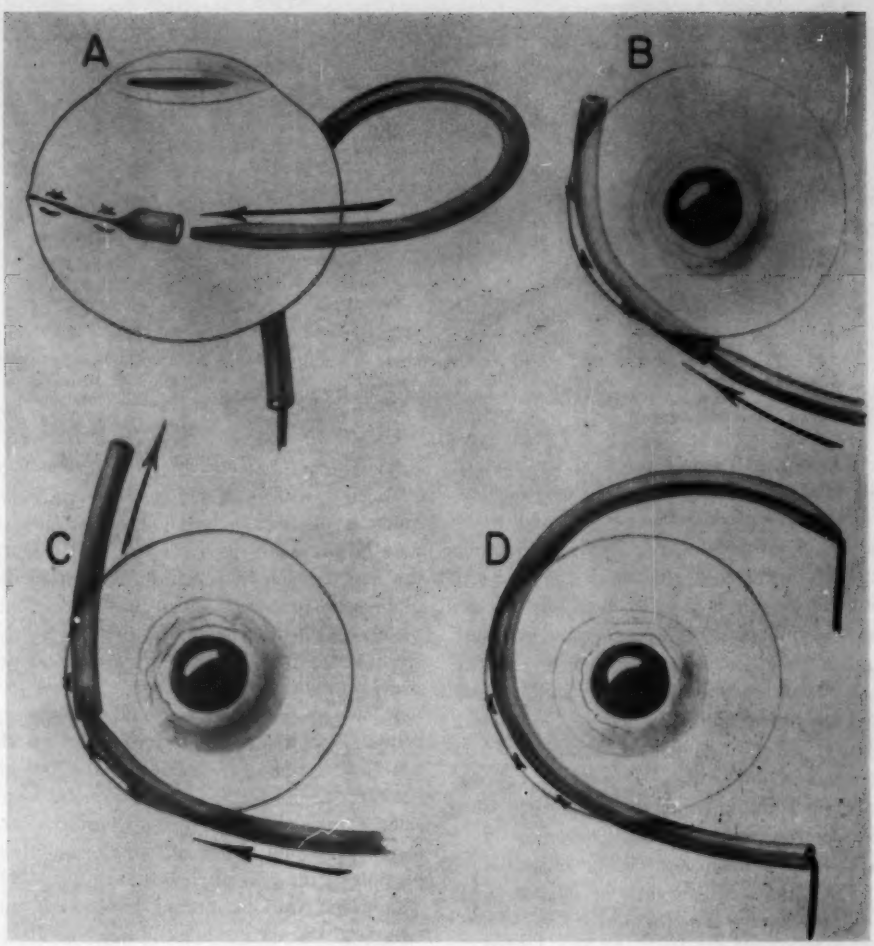



Fig. 2.—Replacing a partial polyethylene tube with a circling tube. *A* and *B*, after removing one suture at each end of the partial tube the tapered end of the circling tube with its 00 nonabsorbable suture is telescoped into the partial tube. *C*, the circling tube is gently pushed into place, while the partial tube is pulled out. *D*, the circling tube is in place.

The circling tube should follow a great circle of the globe as much as is possible. If the buried portion of the tube is equatorial, the circling tube should be completely on the equator. If the buried portion is posterior to the equator, the unburied portion should be placed between the equator and the insertion of the recti muscles. If the buried portion of the tube is anterior to the equator, its unburied portion should be posterior to the equator. When less than one-half the length of the circling tube is buried, its unburied portion may have a tendency to slide away from the great circle and must be anchored.[2] It may be impossible to place the tube over a great circle of the globe; for instance, this may require that the unburied portion of the tube be placed over one or several vortex veins, thereby obliterating them. In this case, the unburied portion of the tube should be moved anteriorly and securely anchored to the sclera.

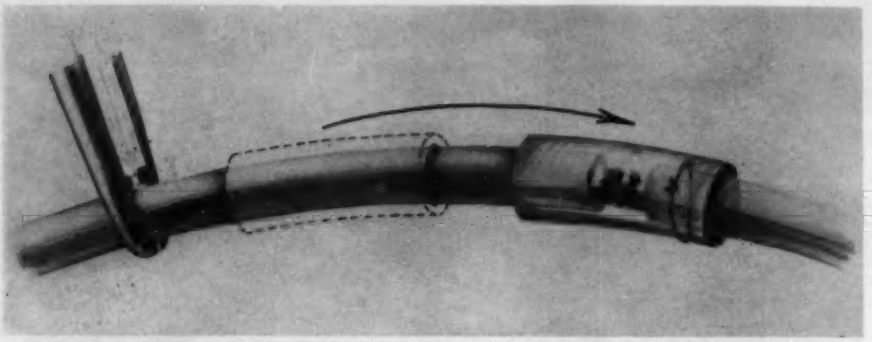


Fig. 3.—Sleeve covering the knot of circling suture. After the knot is tied, a 40% suspension of chloramphenicol is injected into the lumen of the circling tube and a polyethylene sleeve is slid over the knot. A 0000 nonabsorbable anchoring suture is passed through the sleeve and one end of the circling tube.

Subretinal fluid is released by one of the methods described above, and the mattress suture placed over the scleral incision is pulled up and locked. Then the circling tube is shortened so that with a gentle pull there is a gap of about 2 mm. between the ends. A polyethylene tube 8 mm. in length and of large diameter (PE-205)* is passed as a sleeve on the end of the circling tube, and a surgeon's knot is tied on the circling suture. The fundus is now observed. If there is a substantial amount of residual subretinal fluid, the mattress suture over the perforation is loosened and more fluid is allowed to drain out. When examination of the fundus reveals little or no subretinal fluid, the suture over the perforation is tied. The tube may have to be shortened further, and after the circling suture is tied, a suspension of 0.5 gm. of chloramphenicol in 1.2 cc. of water is injected into the circling tube. Then the polyethylene sleeve is slid over the knot on the circling suture and is maintained in place by an additional suture passed through the sleeve and through one end of the circling tube (Fig. 3). This method of handling the circling tube has been found safer than that described in our first article[1] and is currently used in all circling tube operations.

* Supplied by Clay-Adams, Inc., 141 E. 25th St., New York.

*B. Burying a Circling Tube Completely.*

Since a resection completely circling the globe is not advisable in one operation, it may be necessary in a reoperation to carry the lamellar scleral resection all around the globe and to bury the circling tube completely. The sclera and the portion of the circling tube which was left unburied at the previous operation are exposed. In this section, we consider the cases where existing retinal breaks and leaks across the buckle can be closed by extending the scleral buckling completely around the globe. The scleral incisions are made approximately 3 mm. apart, on either side of the unburied portion of the polyethylene tube (Fig. 4*A*). The sleeve over the circling knot is cut and removed, and the circling suture is similarly cut and removed. The lumen of the tube is irrigated with some force to remove any debris. A fresh length of 00 braided nonabsorbable surgical suture is lightly waxed, floated through the tube, and the two ends are loosely tied. If the suture cannot be pushed through the circling tube, a length of wire may first be forced through. The suture is then tied to the end of the wire and gently pulled in place.

A lamellar scleral resection is performed between the two scleral incisions, the tube being held to one side (Fig. 4*B*). Special care should be taken when the ends of the first resection are approached because the

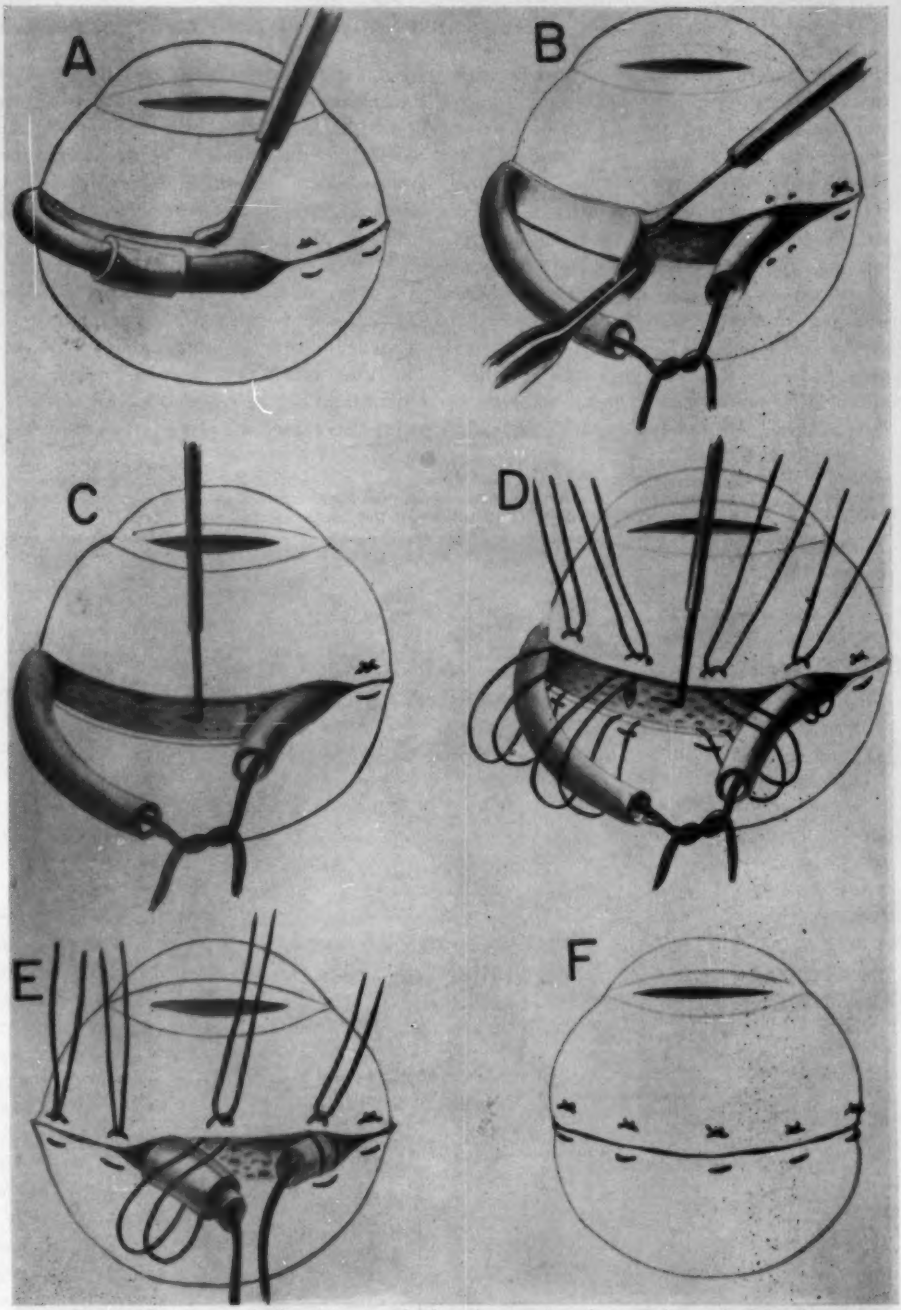
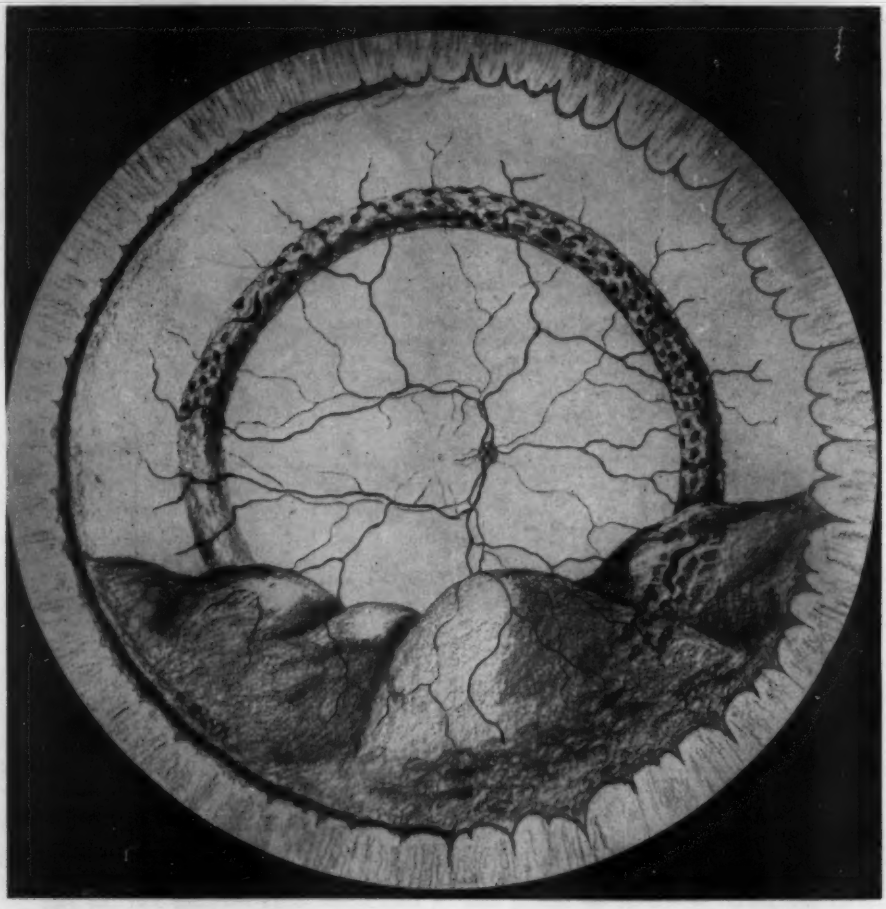



Fig. 4.—Burying a circling tube completely. *A*, assuming that existing retinal breaks can be closed by extending the buckling, an incision is made on each side of the unburied section of the circling tube. *B*, the circling suture is cut and replaced with a fresh one. A lamellar scleral resection is performed between the two incisions. *C*, surface diathermy is applied with a needle electrode. *D*, mattress sutures are placed, and a knuckle of choroid is exposed by a scratch incision and perforated with a fine needle. *E*, the mattress sutures are drawn up except the two across the ends of the circling tube. A polyethylene sleeve is passed over one end, and the circling tube is shortened to appropriate length. *F*, appearance of the globe after the circling suture and the remaining mattress sutures have been tied.

thinned sclera previously treated with diathermy may rupture. Diathermy is applied in the resected area (Fig. 4*C*), after which mattress sutures are placed. Subretinal fluid is released (Fig. 4*D*), and the mattress sutures are drawn up and locked except for the one over the ends of the circling tube (Fig. 4*E*). The tube is shortened so that with a gentle pull there is a gap of about 2 mm. between the ends, and a short sleeve (PE-205) is placed on one end of the circling tube. When ophthalmoscopy reveals that the subretinal fluid has been adequately evacuated, the mattress sutures are finally tied except over the circling suture. Then the circling suture is tied, chloramphenicol suspension is injected into the lumen of the circling tube, and the sleeve is gently slid over the circling knot. The mattress suture located over the sleeve is tied, thereby burying the entire tube (Fig. 4*F*).

*C. Shortening a Circling Tube.*—There are occasions when a circling tube must be shortened in order to obtain a higher buckle. The tube is always shortened when subretinal fluid can be released as, for instance, in the preceding two procedures. However,

Fig. 5.—Recurrence of a retinal detachment five days postoperatively. Diathermy had been applied in the bed of the lamellar scleral resection clockwise from 9:30 to 4 o'clock. The recurrence resulted from insufficient diathermy over the break located at 4 o'clock.



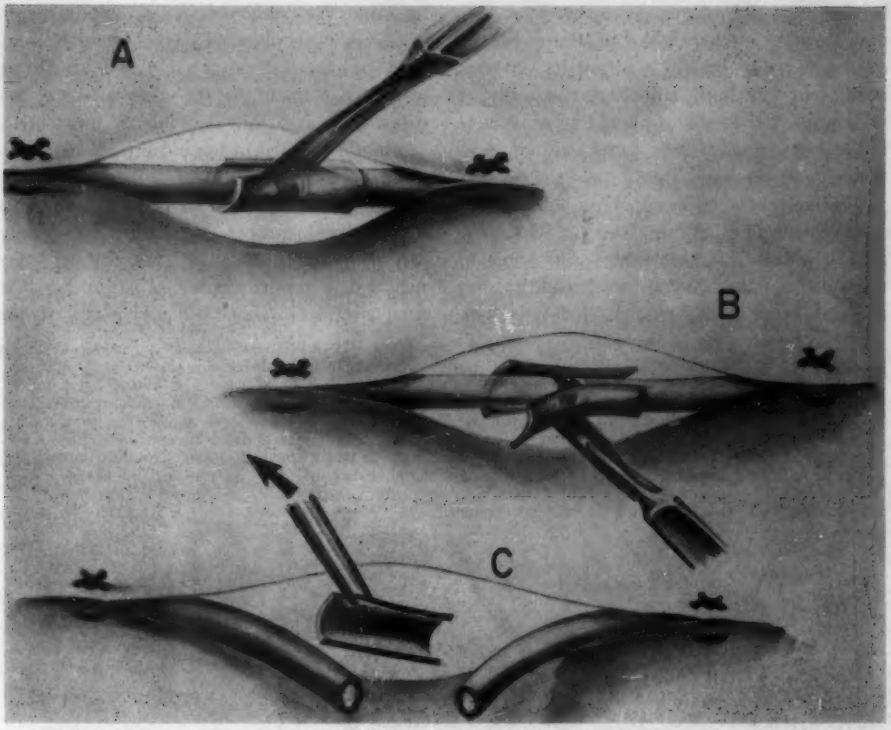



Fig. 6.—Removing a sleeve which is around a buried circling tube. *A*, the buried sleeve is exposed by incising the sclera covering the tube. The sleeve is cut lengthwise with a Bard-Parker knife. *B*, a parallel cut is made in the sleeve and the external half of the sleeve removed. *C*, the knot of the circling suture is cut and the suture removed. The inner one-half of the sleeve is finally removed prior to insertion of a new 00 suture.

there is one situation in which shortening of the tube is used without combining it with any other procedure. Such a situation arises when a scleral buckling is found to be insufficiently elevated in the immediate post-operative period and when there is no improvement of the retinal detachment during the following four to five days (Fig. 5).

The tube is exposed where the circling suture has been tied. If the circling tube was completely buried in the sclera during a previous procedure, it is necessary to open the scleral buckling where the circling suture was tied. The external portion of the polyethylene sleeve on the circling suture is excised with a scalpel (Fig. 6*A* and *B*). The circling suture is cut and removed from the circling tube, and the internal portion of the polyethylene sleeve is then removed (Fig. 6*C*). The circling tube is rinsed with saline, and a new circling suture is threaded through its lumen. Mattress sutures which have been cut to expose the circling tube are replaced, and the subretinal fluid is removed. After all available subretinal fluid is drained, the circling tube is pulled up gently and the operation is completed as described for the previous procedure.

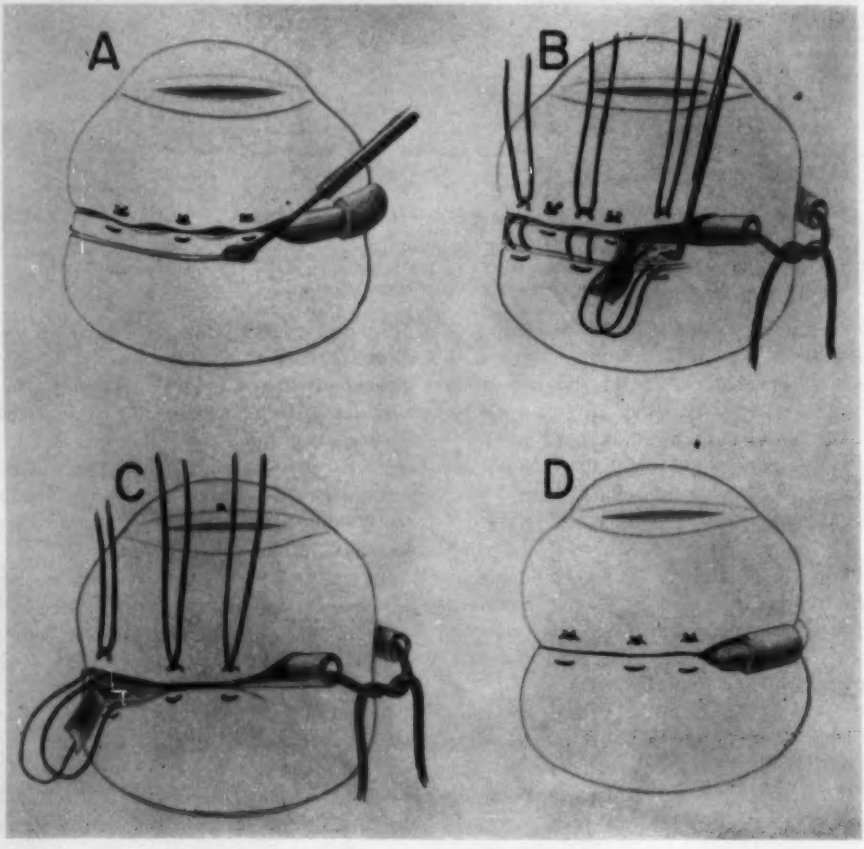
In order to traumatize the eye as little as possible, no additional diathermy is used, since this procedure is generally performed within 5 to 10 days after the first operation. The diathermy applied during the first operation is presumed to be still effective in causing chorioretinal adhesions.

*D. Widening a Scleral Buckling.*—This procedure is performed when a previous buckling is unsuccessful because retinal

breaks were not adequately covered. A leak may develop either on the posterior border of the existing buckling or on its anterior border or on both sides. Accordingly, a widening of the existing buckling may have to be performed either anteriorly or posteriorly or on both sides.

The sclera is exposed, care being taken not to sever the mattress sutures which are still in place. After several weeks some of the sutures may become loose, and, as they are not keeping the scleral edges together, they may be removed. It is important to dissect all vascularized tissue from the surface of the sclera as this will facilitate proper placement of the new mattress sutures. An incision is made 3 mm. away from and parallel to the old line of resection closure (Fig. 7*A*). The fibrovascular tissue bridging the old resection is incised between the mattress sutures, but the sutures themselves are left intact because cutting them may cause the resection to gape. This in turn produces a marked hypotony of the

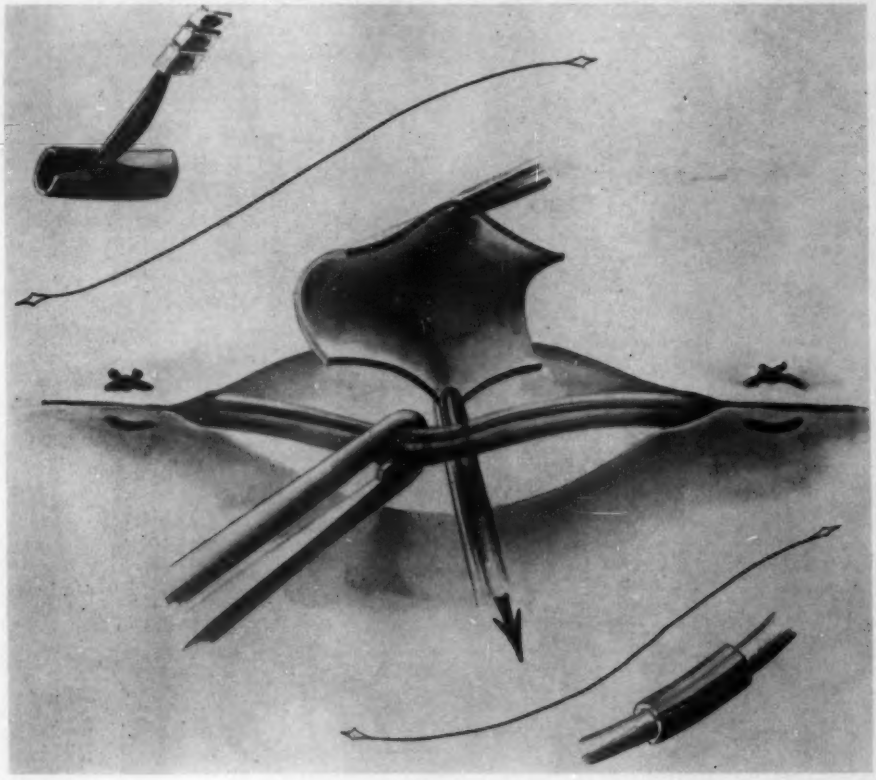
Fig. 7.—Widening a scleral buckling posteriorly. *A*, a scleral incision is made 3 mm. posterior and parallel to the previous resection closure line. The fibrovascular tissue between the mattress sutures is incised. The circling suture is cut and replaced. *B*, new mattress sutures are placed between the old sutures. Resection of the sclera and application of diathermy is carried out 10 to 12 mm. at a time. The old mattress sutures are removed in the process. *C*, as each segment is treated, the new mattress suture over it is pulled up and locked with a single knot. When the resection is completed, subretinal fluid is released by perforating either in the bed of the scleral resection or posterior to it. *D*, completed buckling with circling tube shortened and sleeve placed over it.



globe and makes the remainder of the procedure difficult to perform. New mattress sutures are placed between the old sutures (Fig. 7*B*). The sleeve over the circling suture and the suture itself are cut. The circling suture is withdrawn and replaced as previously described. A lamellar scleral resection is performed between the new incision and the already existing lamellar resection. This necessitates removal of the old mattress sutures and results in widening the resected area of sclera. A strip of sclera measuring no more than 10 to 12 mm. in length is excised at a time. Then diathermy is applied, and the new sutures are pulled up and locked (Fig. 7*C*). This technique helps maintain the tension of the globe and prevents exposure of extensive areas of previously treated and now necrotic sclera. When the lamellar scleral resection is completed, the fundus is examined to find a suitable location for the drainage of subretinal fluid. After release of subretinal fluid, the mattress sutures and circling suture are drawn up and locked. The area of the modified buckling again is carefully checked with the ophthalmoscope. If the result is found adequate, the sutures are tied, and the operation is completed (Fig. 7*D*).

In addition to the above steps, it is sometimes useful to widen the buckle created by the circling tube with a polyethylene sleeve.[2] It is essential to make sure that the sleeve is in the proper location before the mattress sutures and the circling suture are finally tied. If widening of the scleral buckling is done in an area so located that the

Fig. 8.—Adding a polyethylene sleeve when the tube is buried on both sides of the area to be sleeved. The sleeve is slit lengthwise and wrapped around the tube.

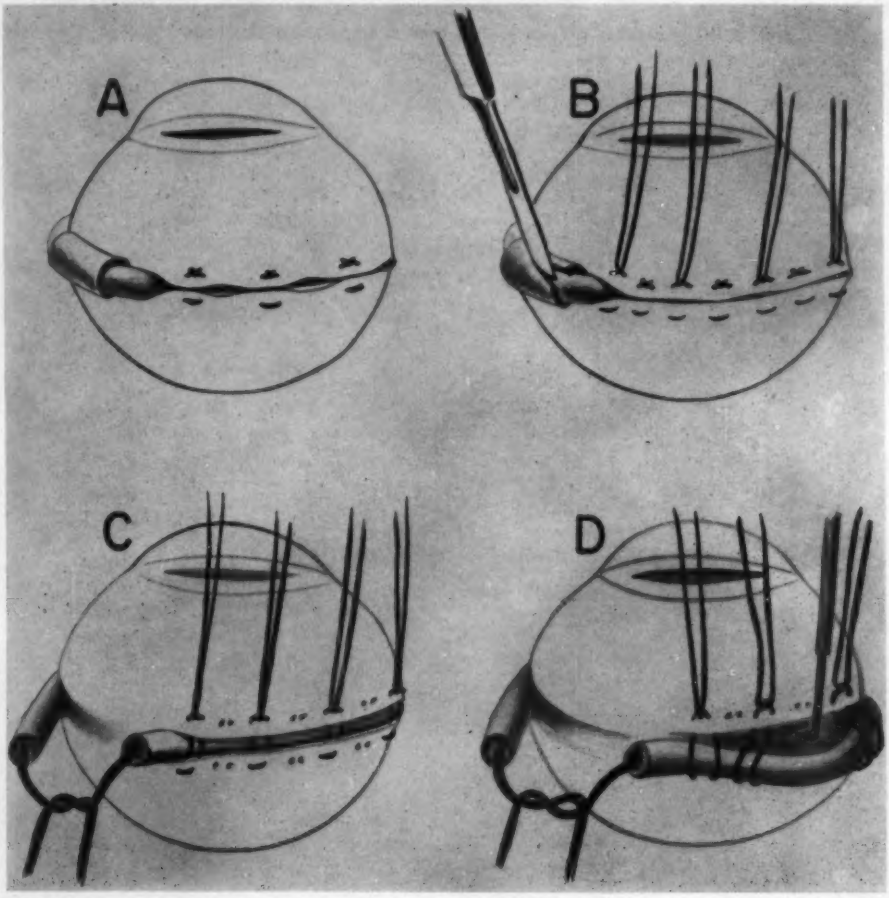


circling tube is buried in the sclera on either side, it is impossible to slide a sleeve on the circling tube from one end of the tube to the area of the widening. It is then indicated to slit the sleeve lengthwise and to insert it as shown in Figure 8.

When ophthalmoscopy of the fundus reveals that the desired result has been obtained, the mattress sutures are tied, the circling tube is shortened as necessary, and the operation is completed as described in Section *A*. It is particularly important, in this operation, that the intraocular pressure not be allowed to rise above normal in tying the circling suture. As the sclera has been previously treated under one portion of the circling tube, pulling too tightly on the circling suture may cause the globe to rupture.

When a previous scleral buckling has to be widened anteriorly and posteriorly, the parallel incisions in the sclera must be placed 1 to 2 mm. on either side of the line of resection closure. This procedure is more hazardous as there is a greater danger of

Fig. 9.—Reapplying diathermy in the bed of an existing buckle. *A*, the previous resection closure line is incised between the sutures. *B*, new mattress sutures are placed and locked with single knots before the old mattress sutures are removed. The sleeve is removed. *C*, the circling suture is replaced. *D*, diathermy is applied with a needle electrode, loosening no more than two sutures at a time.



rupture of the sclera and choroid. It must, therefore, be performed with extreme care.

*E. Reapplying Diathermy in Bed of Existing Scleral Buckling.*—A leak may develop across a scleral buckling because of insufficient diathermy. Reapplication of diathermy is then performed, provided no new or previously undetected retinal breaks are found posterior to the existing buckling.

An incision is made along the existing line of resection closure, being careful not to sever the old mattress sutures at this time (Fig. 9*A*). After new mattress sutures are placed between the old sutures and locked with a single knot, the old sutures are cut (Fig. 9*B*). The knot of the circling suture is exposed and cut, and a new circling suture is put into place as previously described. The buckle is now carefully opened by cutting the old mattress sutures and incising the thin transparent layer of new-formed tissue over the tube (Fig. 9*C*). The tube is gently pulled to one side, and diathermy is reapplied to the bed of the lamellar resection with use of a blunt needle electrode (Fig. 9*D*). Because previously treated sclera is edematous, the diathermy should be 50% to 100% stronger than for application in a primary case. Subretinal fluid is released by one of the procedures already described. The mattress sutures are drawn up and locked, and the circling tube is shortened as much as the decreased volume allows. The fundus is examined before the sutures are finally tied.

In our series of detachments, insufficient diathermy is more commonly encountered than too intense diathermy. It is preferable to err on the side of insufficient rather than excessive diathermy, for in the latter case, a second operation may be extremely difficult to perform.

## II. Additional Scleral Bucklings

If a circling tube is already in place, it may be necessary to create an additional scleral buckling. This can be accomplished with a trap-door procedure, with a second circling tube, or with a meridional tube placed under an existing circling tube. The techniques generally used for trap-door procedures have already been described.[1,2]

*A. Second Circling Polyethylene Tube.*—Although a second circling tube may be placed either anterior or posterior to the existing circling tube, the posterior location is more commonly used, and the technique of this procedure will be described in detail.

The sclera is exposed in the usual manner, and an incision is made 1 to 2 mm. posterior to the existing line of resection closure. As in a primary procedure, this incision should not be much longer than one-half the circumference of the globe. A parallel incision is then made about 3 mm. posterior to the first incision, and a lamellar scleral resection is performed (Fig. 10*A* and *B*). An alternative method is to make the anterior incision only, to undermine the scleral flap posteriorly for about 3 mm., and to excise it with scissors.[2] Either method produces a 3 mm. wide strip of resected sclera which is separated from the previous buckle by a 1 to 2 mm. strip of unresected and untreated sclera. This strip helps to prevent over-riding of the new tube over the old. Surface diathermy is applied to the resected area as usual. Mattress sutures are placed across the treated sclera in a manner slightly different from that used in a primary procedure. The first bite is in the anterior lip of the old buckle, the second is in the 1 to 2 mm. strip, which forms the posterior lip of the old buckle (Fig. 10*C*). If the edges of the old buckle have been tightly approximated, a single, long bite may be taken through both the anterior and posterior lips. It should be kept in mind that adjacent to the buckle, the choroid may be easily perforated with a suture needle, since there is generally a furrow where the choroid is closer to the surface on either side of the buckling (Fig. 11). Passing the mattress suture through the posterior edge of the lamellar resection presents no special problems. From this point on, the procedure is identical to a primary operation with circling tube.[1] When the suture in the second tube is being tied, it

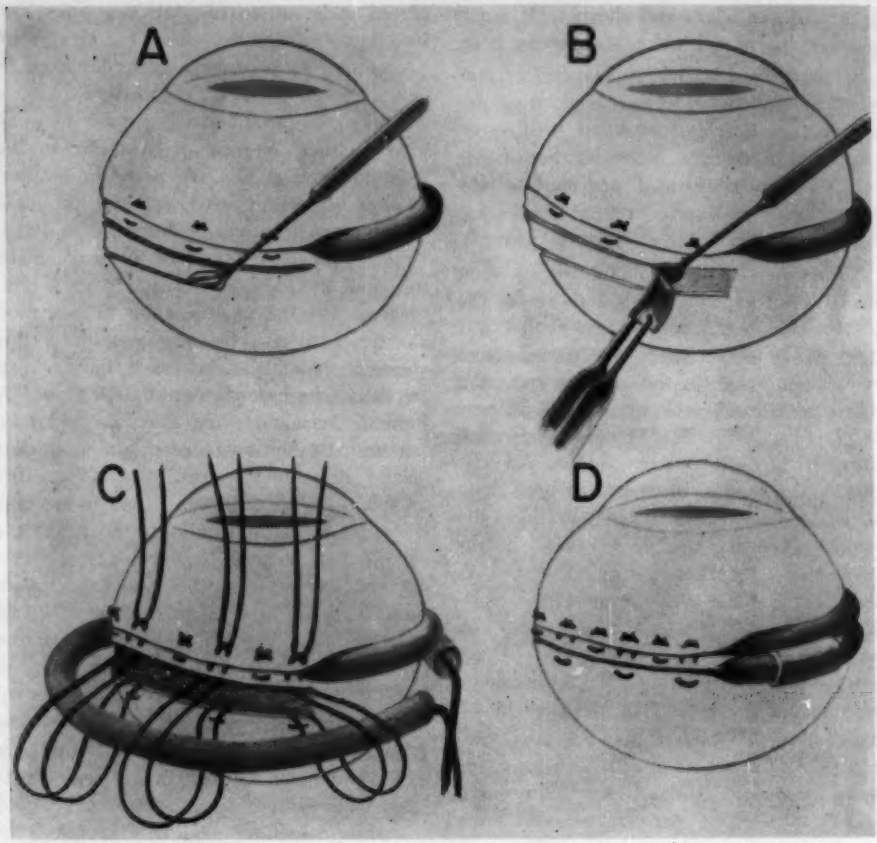



Fig. 10.—Adding a second circling polyethylene tube posterior to the existing tube. *A*, incisions 3 mm. apart are made posterior to the previous buckling closure line. *B*, a lamellar scleral resection is performed. *C*, diathermy is applied to the bed of the resection and 0000 nonabsorbable mattress sutures are placed. The sutures are passed through the anterior and posterior lips of the previous resection to prevent the second circling tube from over-riding the existing tube. The second circling tube is placed under the mattress sutures and after the choroid is perforated, the circling suture is tied. *D*, a sleeve is used to cover the knot of the second tube. The first circling tube generally must be shortened so that it forms a circle of approximately the same size as the second tube.

may be necessary to shorten the old tube, and this is done as described previously in this article.

*B. Meridional Tube Under a Circling Tube.*—When a leak of subretinal fluid exists across a scleral buckling owing to a high retinal fold, this may be corrected by a meridional polyethylene tube inserted under the circling tube over the location of the fold. The procedure is particularly recommended when the circling tube has not been shortened very much.

After proper exposure, the circling suture is cut and replaced. The future location of the meridional tube is determined accurately by ophthalmoscopy. An incision is then made over the buried portion of the circling tube, deep enough to expose the tube, and extending about 10 mm. on either side of the future location of the meridional tube. The cut mattress sutures are replaced by new sutures which are pulled up and locked. A lamellar scleral resection 3 to 4 mm. wide and 8 to 12 mm. long is per-

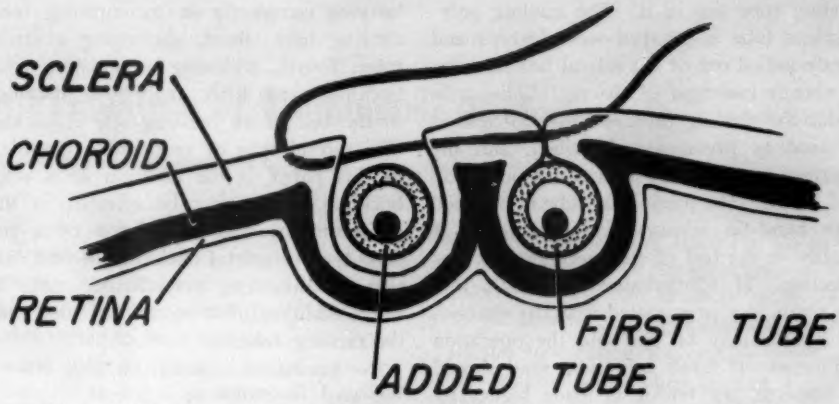
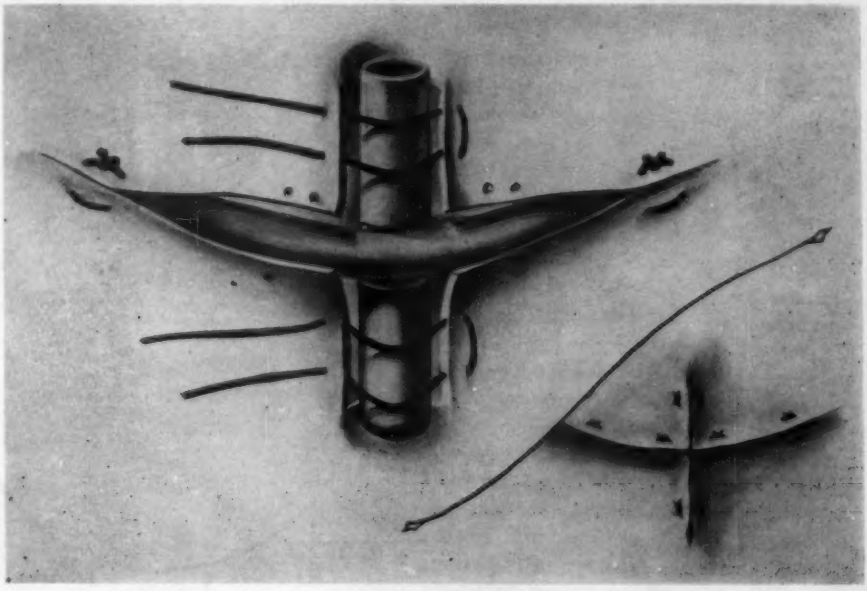



Fig. 11.—Section across two circling tubes showing the choroidal furrow which may be perforated if the suture needle is placed too deeply.

formed in a meridional direction in such a way that it extends 4 to 6 mm. on either side of the circling tube (Fig. 12). One or two mattress sutures are placed across the resected portion, and diathermy is applied in the bed of the resection. The polyethylene tube which is to be placed under the new mattress sutures is generally of large diameter (PE-190 or PE-205), and it is cut several millimeters longer than the resected area. It is often useful to make a notch in the meridional tube so that the

Fig. 12.—Meridional tube under a circling tube. A lamellar resection is performed at right angles to the equatorial resection and diathermy applied in the usual manner. Generally, one mattress suture anteriorly and another posteriorly is sufficient to buckle in the short tube. A notch is cut in the short tube to prevent its sliding out of position. As the figure indicates, the meridional tube is cut a little too long, then it is trimmed to the proper size after it has been placed in the bed of the buckle. The insert shows scleral incisions after closure.



circling tube fits in it. The circling polyethylene tube is grasped with forceps and gently pulled out of the scleral bed in order to permit insertion of the meridional tube under the circling tube. Subretinal fluid is released as previously described, and the mattress and circling sutures are pulled up and locked. The meridional tube is trimmed with blunt-tip scissors, in order to fit it exactly in the bed of the meridional scleral resection. If ophthalmoscopy reveals that the retina is approximated with the choroid, all sutures may be tied and the operation completed. If more subretinal fluid should be released, the buckle is made higher by shortening the circling tube.

## Summary

When a reoperation is performed after an unsuccessful scleral buckling, two types of procedure may be considered. In the first type, the existing scleral buckling is modified. Such modification may be effected in the following five ways: first, replacing a partial tube by a circling tube; second, burying completely an incompletely buried circling tube; third, shortening a circling tube; fourth, widening an existing scleral buckling, and fifth, reapplying diathermy in the bed of an existing scleral buckling. The second type of reoperation considered in this paper is the addition of a scleral buckling. This may be effected in three different ways: first, addition of a trapdoor type of scleral buckling; second, addition of a circling polyethylene tube, and third, addition of a meridional tube under the circling tube.

The illustrations in this article were drawn by William J. Stenstrom.

99 W. Cedar St. (14).

## REFERENCES

1. Schepens, C. L.; Okamura, I. D., and Brockhurst, R. J.: The Scleral Buckling Procedures: I. Surgical Techniques and Management, A. M. A. Arch. Ophth. 58:797-811, 1957.

2. Schepens, C. L.; Okamura, I. D., and Brockhurst, R. J.: The Scleral Buckling Procedures: II. Technical Difficulties of Primary Operations, A. M. A. Arch. Ophth. 60:84-92, 1958.

# An Evaluation of Tonometric Techniques

K. ELIZABETH PIERCE OLMSTED, M.D., Buffalo

The eye is a sphere-like organ whose encasement is an elastic, tensile, semirigid structure. The problem of measuring the intraocular pressure, therefore, becomes complex owing to these structural characteristics and their variability. If the eye were an inelastic nonrigid structure so that its envelope did not resist distortion, and the tonometer weight were very small so that it displaced practically no volume, *Vc*, then the weight, *W*, would simply be supported by the intraocular pressure, *P*, over the plunger area, *A* ($W=PA$) (Fig. 1).

Two methods of measuring this pressure have been employed, the indentation type of Schiøtz, Gradle, and McLean and the aplanation technique of Goldmann.

In any tonometer there is a finite change of volume, *Vc*, which distends the eye and brings into play elastic tensile forces and a rise in internal pressure from *Po*, the pressure in the eye before the application of the tonometer, to *Pt*, the pressure in the eye with the tonometer weight applied.

Submitted for publication Feb. 2, 1959.

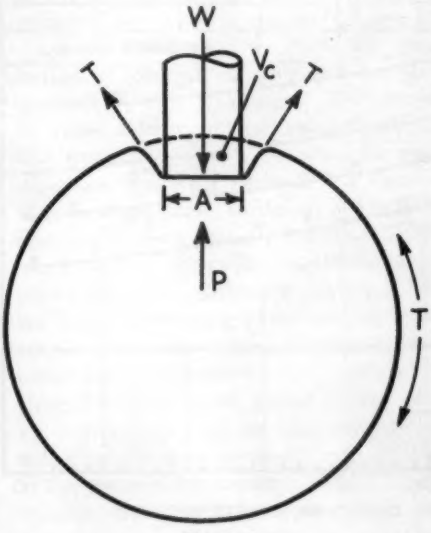



Figure 1

In the indentation tonometers relatively heavy weights are applied so that *Vc*, the volume displaced, is large and *Pt* is significantly greater than *Po*. The magnitude of this difference is a function of the elasticity of the eye so that any single calibration is valid only for given elastic characteristics. The scale which accompanies the tonometer has been calibrated to read directly in the *Po* values of an eye with average elastic tension properties and, therefore, average volume change, *Vc*, when the plunger sinks to a position indicating *Po* on its scale. This calibration was originally made by Dr. Hjalmar Schiøtz, of Oslo, Norway, in the years 1905 to 1924, along with his development of the first indentation tonometer. Using whole enucleated eyes a cannula was inserted into the eye and connected to a manometer. Data were obtained for internal pressure ranges at various plunger loads and summarized in a simplified calibration curve. As a result of the method of averaging, the calibration scale is more accurate between Readings 3 and 10 with increasing deviation outside these figures.

During the 1940's, Dr. Jonas Friedenwald repeated these experiments using a more sophisticated apparatus to simulate ocular conditions in an effort to ensure a higher degree of concordance in clinical measurements with different plunger loads. Theoretically an eye should then indicate the same *Po* value for any tonometer weight. This again is true for eyes with average elastic properties. However, some eyes give higher or lower readings with

heavier weights indicative of variation in the structural properties or ocular rigidity. In order to get at the mechanism of these variations Friedenwald, using excised corneas in a manometer setup, made further measurements of the actual volumes, *Vc*, displaced by the tonometer at different "intraocular pressures" and tonometer weights. Combining his two sets of data he developed the mathematical relationship between *Po*, *Pt*, *Vc*, and a rigidity coefficient, *K*, which describes the elastic properties of the eye. With use of this relationship it is possible to employ the variation with plunger load of indicated intraocular pressure as a means of measuring the ocular rigidity. When this rigidity has been so determined it can be used to correct from the standard calibration to the *Po* of the given eye. These operations are conveniently performed with use of the pressure rigidity nomogram published by Friedenwald in 1955 (Fig. 2). If tonometer readings are obtained using the 5.5 gm. and the 10 gm. weights, respectively, the slope of the line connecting them indicates rigidity on the rigidity coefficient scale. Extending the line at this slope to the pressure scale indicates corrected *Po* for the measured eye. It will be noted that the relatively small spread of *Vc* values obtained with available weight variations renders this correction relatively sensitive to error.

A further error associated with the relatively large *Vc* displacement of the indentation tonometer lies in its significant variation with corneal curvature. An apparent variation in the rigidity coefficient of 30% can enter with extreme variation of the human corneal radius. While some of this error seems fortuitously to be compensative in the two-weight measurements above, there is no formal correction of the calibra-

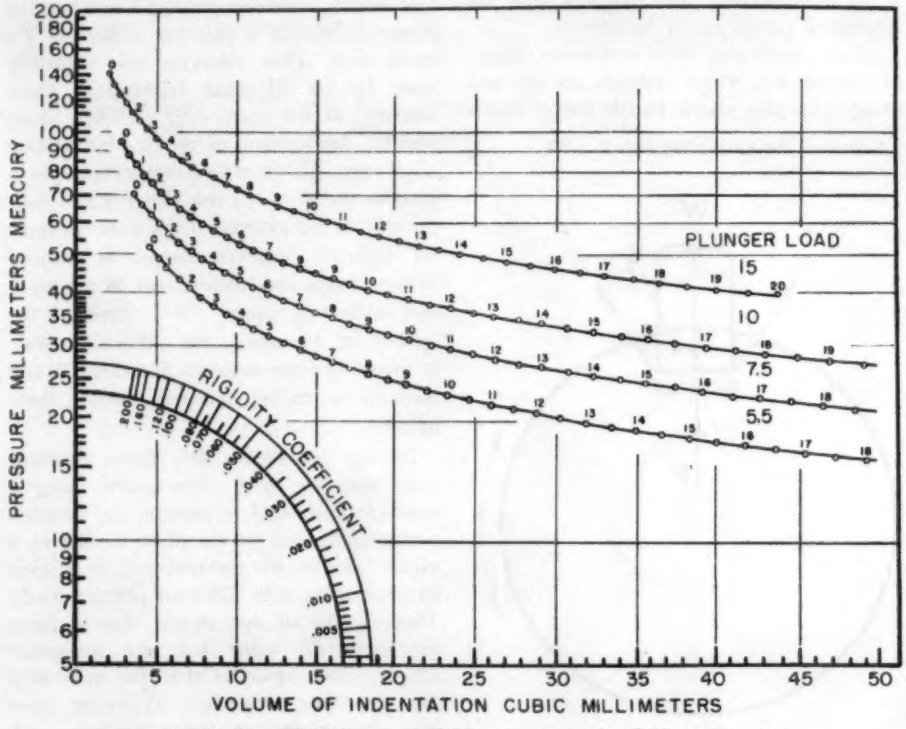



Fig. 2.—Friedenwald 1955 pressure rigidity nomogram for Schiøtz tonometer.

tions. Significant residual errors in corrected *Po* seem always to be associated with the high displacement instruments.

We have noted the actual pressure change from *Po* to *Pt* induced by tensile forces in the outer coats of the eye when distended to accommodate the volume change, *Vc*. These tensile forces, *T* in Figure 1, act everywhere tangent to the scleral-corneal surface. At the corneal indentation they therefore act outward and upward imparting a lifting component of force to the tonometer plunger which appears like an additional component of *Pt*. The magnitude of this error again increases with *Vc*, as increasing depth brings the *T*-forces closer to full vertical action. Thus their contribution of error may be calibrated out for the average eye, but variations from the average add a further increment to the apparent ocular rigidity.

As the cornea is a semirigid structure, another residual "scleral rigidity" error is found in the actual bending of the membrane against its bending rigidity. Observe again Figure 1. There is a deep double bend in the cornea resulting from the plunger distortion. Corneal rigidity resists the indentation in a manner indistinguishable from pressure, *Pt*. Again this error is calibrated out only for the average eye.

Let us briefly review, then, the error factors in indentation tonometry for later comparison with aplanation. The altered *Pt* value, due to volume change, varying with ocular elasticity is probably the most important. Since the *Vc* itself is a function of corneal curvature, variations of the latter from average undoubtedly constitute a substantial error. Next in magnitude is the tensile component lifting the tonometer load and lastly, the bending of the anterior structures. These have been lumped together under Dr. Friedenwald's term "scleral rigidity," and the determination of the rigidity coefficient is used for the correction of individual pressure reading.

The aplanation tonometer differs fundamentally from the indentation type in that it is a constant-displacement, variable-force type as contrasted with the constant-force, variable-displacement principle of the indentation type. Since the errors analyzed above are associated largely with the varying displacement *Vc* associated with different rigidity characteristics of individual eyes, this distinction immediately appeals in favor of the aplanation type. Specifically Dr. Hans Goldmann and Dr. W. Schmidt have capitalized this advantage in their instrument which has minimized the displaced volume, *Vc*, to the smallest value consistent with certain properties of the corneal anatomy. In their design a Plexiglas plate is brought into contact with the cornea by means of a calibrated spring, pressure of which is increased until an area of predetermined size is flattened, as shown in Figure 3. The intraocular pressure, *Pt*, is then determined as the spring force, *W*, divided by area, *A*. Certain properties of the corneal structure modify the internal area, *A*, exposed to intraocular pressure from the observable externally flattened corneal area. If sufficient area is flattened this difference becomes negligible. Drs. Goldmann and Schmidt have optimized in their design the balance between this minimum area and the requirement that *Vc*

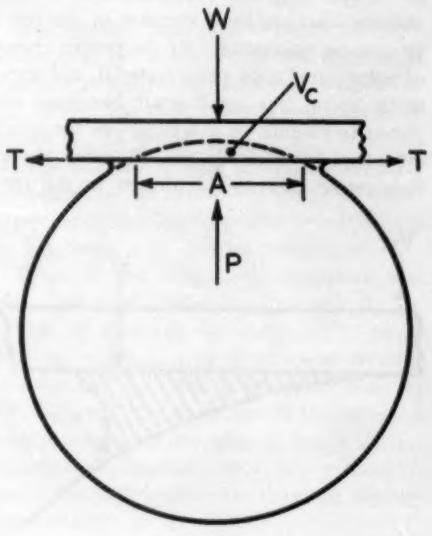



Figure 3

be kept small. The final *Vc* of their design is constant at 0.44μL. as contrasted with variable values of 10μL. to 20μL. for the indentation types.

As a result of this small volume change, the effect of variable scleral rigidity, *K*, is minimized and *Po* equals 0.98 *Pt*. *Pt* and *Po* may be considered clinically equal, provided that the cornea is not altered by edema or external agents. Since the effect of corneal curvature variation is simply to alter *Vc*, curvature may be neglected at the small displacement of this instrument.

A further advantage of the aplanation pattern is immediately obvious from Figure 3, in that tensile forces, *T*, lie in the plane of the plate and perpendicular to the line of action of *W*, so that they have no components tending to oppose *W*.

While the effect of corneal bending rigidity is not completely eliminated, it is small and constant. Contrast Figure 3 and Figure 1. It combines with pressure effect of elastic variations acting over the small volume change, *Vc*, to make up the minimized structural error of this instrument.

An error specific to the aplanation mechanism lies in the surface tension attraction between the wetted plate and the surface of the eye (Fig. 4). This introduces a small and constant apparent increase in the force *W* causing aplanation. By the proper choice of aplanatated area, plate material, and anesthetic agent, this small error has been adjusted to balance in a normal eye the small difference between *Po* and *Pt* noted above. Because of this careful design to the surface tension factors it is important to use the recommended anesthetic, i. e., benoxinate (Novescine, 0.05%, or Dorsacaine) and to follow instructions in cleaning the aplanation plate to protect its silicon coating.

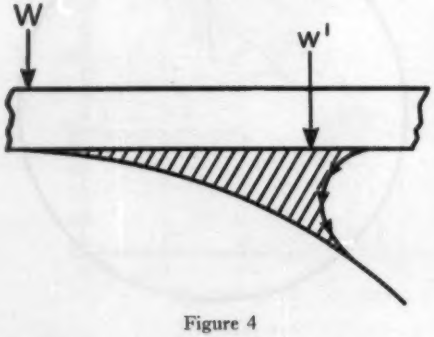



Figure 4

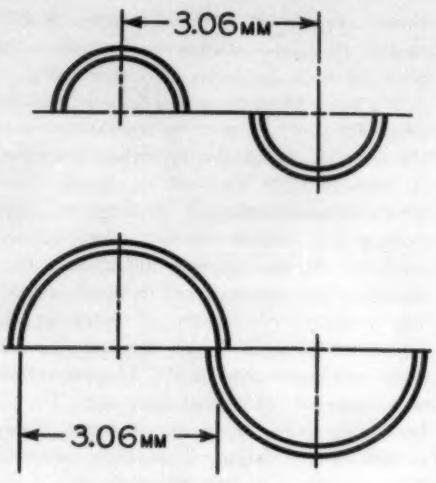



Figure 5

Figure 5 illustrates the ingenious mechanism employed to obtain a standard area of aplanation. The aplanation plate comprises on its anterior face a pair of prisms which offset the two halves of an image of the contact area by 3.06 mm. The contact area is made visible by the use of fluorescein dye which marks its capillary outline when viewed by blue light. Observing this image through the biomicroscope, the spring force, *W*, is increased, increasing the aplanated area until its standard diameter, 3.06 mm., is indicated by the inner touching edges of the two half-images. The intraocular pressure is read directly from the spring drum.

Figure 6 indicates the elliptical aplanation which replaces the circular pattern of contact when the eye is highly astigmatic. A diameter at 43 degrees to the major axis of this pattern or the axis of the minus cylinder will describe a circular contact of equivalent area. By adjusting the field split along this axis astigmatic error in aplanation area is avoided.

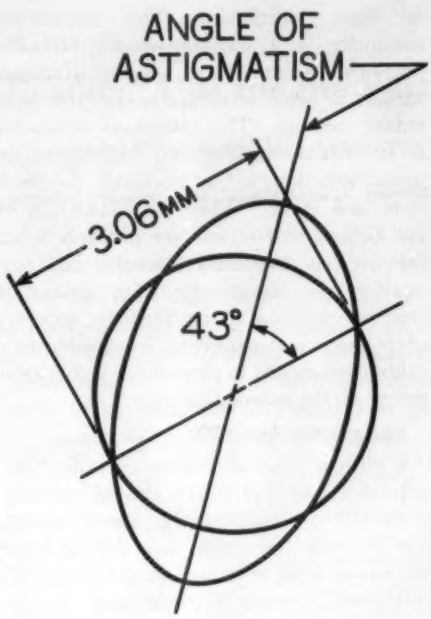



Figure 6

In cases where clinical measurements of pressure indicate adequate therapy but the clinical course is one of progressive deterioration, it is particularly desirable to investigate the possibility that ocular rigidity factors have given a false pressure reading. In this situation the low residual error of the aplanation instrument is significant. In addition to its intrinsic validity, it may be employed to validate later determinations of the Schiøtz tonometer by correcting from its average calibration to one appropriate to the individual patient. This is accomplished by making a more accurate determination of ocular rigidity than is possible with the "two-weight method" described for the Schiøtz. It will be remembered that this method suffers from narrow spread between readings associated with practical weight variations (10 to 5.5 gm. on the Schiøtz). The aplanation type constitutes in effect a "zero weight" (or 0 *Vc*) type. An accurate rigidity coefficient slope may then be obtained by connecting the aplanation instrument's pressure reading on the left hand scale of Figure 2 with the point on the curve appropriate to the plunger load used in a concurrent Schiøtz tonometer determination. Usually the 7.5 gm. weight will be optimum. Subsequent readings of the Schiøtz scale will be converted to valid *Po* readings for this patient by projecting them along a line of this slope to the pressure scale. The slope may, of course, be most conveniently recorded for this purpose as the "rigidity coefficient" obtained by transferring it to the scale in the lower left hand corner of Figure 2.

It will be recognized that there is additional utility to such an accurate determination of rigidity coefficient in tonography where it has bearing upon determination of the outflow coefficient.

The Schiøtz tonometer has for 25 years been a valuable aid to the diagnosis and treatment of glaucoma. Little change has been made, however, from the original design. Improvements have consisted primarily in standardization of the manufactured product and calibration of the individual instrument, initiated by the Committee for Standardization of Tonometers. It is important to recognize the limitations inherent in the Schiøtz type. When these are properly taken into account it is a very useful tool.

It is equally important to note that these limitations are overcome by the aplanation instrument, used either as a replacement for the indentation type or as a supplementary means of its calibration. It is also noteworthy that the aplanation type is uniquely advantageous in early postoperative measurements where its very light pressure may be employed with greater confidence.

While it had long been recognized that the aplanation approach is intrinsically superior in principle, its early reduction to practice was not as satisfactory as was the development of the indentation type by Dr. Schiøtz. Dr. Goldmann's improvement was based in his recognition that a certain optimum aplanation must be realized to sense the true intraocular pressure through the structure of the globe.

In tonography optimum results are obtained by using both instruments. The indentation type is presently necessary to the outflow measurement, while the combination of the two affords the more accurate determination of the critical ocular rigidity coefficient.

## Summary

The problems encountered in the clinical determination of intraocular pressure are discussed, and two means of measurement are described, i. e., the indentation type of Schiøtz and the aplanation of Goldmann. Emphasis is placed on the basic difference in these techniques. The indentation tonometer is a constant-weight, high-displacement instrument, readings of which are subject to wide structural error and individual variance. The aplanation tonometer is a constant-displacement, variable-weight instrument designed to minimize the small structural error. When the limitations of the Schiøtz instrument are properly taken into account it remains a valuable tool, particularly in tonography. The aplanation type, in addition to its intrinsic accuracy of primary measurements, is valuable as a calibration means to extend the tonographic utility of the indentation type.

568 Lafayette Ave. (22).

# Reading Aids for the Partially Blind

*Classification and Measurement of More Than Two Hundred Devices*

LOUISE L. SLOAN, Ph.D., and MARIA D. JABLONSKI, F.B.O.A., Baltimore

## Introduction

In the past few years there has been a growing awareness of the possibilities of giving useful reading vision to the partially blind patient.[1-9] One of the obstacles to more widespread use of optical aids for subnormal vision is the great number of such devices needed to provide for each patient the one which best meets his particular needs. A complete assortment of reading aids not only must cover a wide range of powers but must have several different types in each power. For certain near-vision tasks other than reading, a head-borne device, which leaves the hands free, may be essential. Some of those who require or prefer a magnifier in the form of spectacles will need a bifocal type; some can use a unifocal (single vision) type. Other patients will find it difficult to hold the reading page at the proper distance from the spectacles and will prefer a stand-magnifier. Those who need a great deal of light on the page comprise a special group who should have an illuminated magnifier. Other features which may be of importance are portability, cost, extent of visual field, working distance, etc.

The fact that many devices are needed to meet the requirements of different patients would not present as great a problem if these were classified in some orderly system according to type and power as are, for example, the plus and minus spheres and plus and minus cylinders of the trial case. At the present time no consistent system is used to rate all magnifiers in comparable units according to power. A majority are specified by their manufacturers in terms of conventional magnification, defined as dioptric power divided by four. Some are specified directly in terms of dioptric power, others in terms of focal length in inches or in centimeters. In the case of thick lenses and compound lenses the front and back vertex powers and the true equivalent power of a given magnifier may be very different. It is not always recognized that equivalent power is the only correct specification for a lens used as a simple magnifier.*

## Purpose of Present Study

The present study is an attempt to bring order into the chaotic situation as regards specification of optical aids in order to simplify and standardize the procedures for prescribing these aids. This paper presents (1) a detailed classification of reading aids into four main types and several subtypes; (2) precise data on their equivalent dioptric powers and other pertinent data regarding their optical characteristics; (3) comparative measurements of the extent of the useful field provided by the different devices; (4) classification of the reading aids to show the approximate level of visual acuity for which each is suited. The acu-

Submitted for publication Jan. 29, 1959.

From the Wilmer Ophthalmological Institute of The Johns Hopkins University and Hospital. This investigation was supported by Grant B-810 from the National Institutes of Neurological Diseases and Blindness, Public Health Service.

* The back vertex power, normally used in specifying lenses used to correct errors of refraction, has no meaning in the case of a reading aid whose function is simply to provide a large retinal image. The front vertex power is, on the other hand, of some interest because it determines the distance of the reading page from the front surface of the lens.

ities used in this classification are those measured at 40 cm. with reading cards specially devised for this purpose.

### I. Classification of Reading Aids According to Type, Power, and Level of Acuity for Which Each Is Suited

*Type I. Spectacle and Other Head-Borne Reading Aids.*—The reading aid most frequently used by the ophthalmologist is a strong convex lens or pair of lenses worn on the face in or close to the normal spectacle plane. These lenses may be unifocal (single vision) spectacles or may be similar to conventional bifocals in that the reading lens covers only a portion of the field of vision. Examples of unifocal reading aids are the I-Gard Hyperocular, Volk Conoid, and Feinbloom Microscopic lenses. The bifocal group includes reading *additions* whose power is added to that of the distance portion. The Continental and the AO "Microscopic" lenses are of this type. It also includes reading *inserts* in which the reading lens is placed in an aperture in the lower part of the eye-glass. Some of these inserts can be prescribed as spherical lenses only; others can include correction for an astigmatic error of refraction. The Keeler and Policoff Bifocals are of the insert type.

Jeweler's loupes, and similar devices which are attached to the spectacle frame or to a headband, also belong to the group of head-borne reading aids. As a rule, these are monocular and can be classed as of the bifocal type because they do not cover the entire field of vision. Since the power of the loupe is added to that of the distance correction they should be classed as reading additions rather than as reading inserts. The Bausch & Lomb Eye Glass Loupes, Selsi Loupes, May Loupes, and Magnifocusers are examples.

In optical aids of high dioptric power special consideration must be given to the reduction of aberrations, either by a suitable choice of lens shape ("best form" lens), by the use of aspheric surfaces, or by the substitution of a compound lens (i. e., a doublet or triplet) for a single lens. Some of the Keeler magnifiers are "best form" lenses. Aspheric curves are used for the Hyperocular and Volk unifocal lenses, for the Keeler bifocal inserts, and for the AO bifocal additions. The Feinbloom Microscopic Lenses are doublets.

Another form of compound lens, the telescopic loupe, is composed of plus and minus lenses separated by an interval. In this type of reading glass, the reason for using more than one lens is not to reduce aberrations but to increase the working distance. When the component closer to the eye is a minus lens, the principal planes are shifted outward and the equivalent power is therefore greater than the front vertex power. Such a lens has a longer front focal length and thus a greater working distance than a thin lens of the same equivalent power. Reading aids designed to give a longer working distance include the Keeler Full Field and Bar Type Telescopic Units, the Optikon, the Barrett Monoculars, and the Aloe and Neico Monocular Loupes. The same principle can be applied to obtain a telescopic reading glass by adding a convex lens to the front of a Galilean telescope for far vision. When, for example, a +6 D. reading cap is placed over a × 1.7 Galilean telescope the combination has an equivalent power of 1.7×6, or 10.2 D., an anterior vertex power of 6 D., and a working distance, therefore, of 16.7 cm. measured from the front surface. A single thin lens of the same equivalent power has a working distance of only 9.8 cm.

The Appendix describes the equipment and procedure used to measure the equivalent and anterior vertex powers and other pertinent optical characteristics of the various reading aids. Tables 1 and 2 list magnifiers of Type I in order of equivalent power. The devices listed in Table 1 are simple or compound lenses whose anterior focal lengths are equal to or slightly less than their equivalent focal lengths. Table 2 lists telescopic reading aids, i. e., those whose anterior focal lengths ($f_a$) are

TABLE 1.—*Head-Borne Reading Aids* *

| Manufacturer's Designation | Source † | $D_o$ and $M_{10}$ Rating ‡ | | Description |
|---|---|---|---|---|
| Keeler Ill. Spec. Mag., × 20 | K | | 74 | Unifocal, compound lens, with distance control |
| Feinbloom "Microscopic", × 20 | F | | 66 | Unifocal, compound lens |
| Feinbloom "Microscopic", × 18 | F | | 62 | Unifocal, compound lens |
| Keeler Ill. Spec. Mag., × 15 | K | | 59 | Unifocal, compound lens, with distance control |
| Volk Conoid, "100 D" | ABC | 20 M | 56 | Unifocal, aspheric glass lens |
| Feinbloom "Microscopic", × 16 | F | | 55 | Unifocal, compound lens |
| Volk Conoid, "80 D" | ABC | | 53 | Unifocal, aspheric glass lens |
| Policoff, × 14 | P | | 50 | Bifocal insert |
| Feinbloom "Microscopic", × 14 | F | | 50 | Unifocal, compound lens |
| A. O. Aspherical, × 12 | AO | | 47 | Aspheric plastic bifocal with plano distance Rx § |
| Keeler Ill. Spec. Mag., × 12 | K | | 47 | Unifocal, compound lens with distance control |
| Volk Conoid, "60 D" | ABC | | 47 | Unifocal, aspheric glass lens |
| Keeler Ill. Spec. Mag., × 10 | K | | 45 | Unifocal, compound lens with distance control |
| Feinbloom "Microscopic", × 12 | F | | 44 | Unifocal, compound lens |
| A. O. Aspherical, × 10 | AO | 14 M | 39 | Aspheric plastic bifocal with plano distance Rx § |
| A. O. "Microscopic", × 10 | AO | | 39 | Bifocal insert, compound lens |
| Volk Conoid "50 D" | ABC | | 39 | Unifocal, aspheric glass lens |
| Policoff, × 10 | P | | 37 | Bifocal insert, compound lens |
| Feinbloom "Microscopic", × 10 | F | | 37 | Unifocal, compound lens |
| Volk Conoid, "40 D" | ABC | | 35 | Unifocal, aspheric glass lens |
| Keeler Bifocal, × 9 | K | | 35 | Bifocal insert, aspheric plastic lens |
| A. O. Aspherical, × 8 | AO | | 31 | Aspheric plastic bifocal, with plano distance Rx § |
| A. O. "Microscopic", × 8 | AO | | 31 | Bifocal addition |
| Volk Conoid, "35 D" | ABC | | 31 | Unifocal, aspheric glass lens |
| Hyperocular, × 8 | ML | | 30 | Unifocal, aspheric plastic lens |
| Feinbloom "Microscopic", × 8 | F | 10 M | 30 | Unifocal, compound lens |
| Keeler Aspheric, × 8 | K | | 30 | Unifocal, with distance control |
| Keeler Bifocal, × 8 | K | | 29 | Bifocal insert, aspheric plastic lens |
| Volk Conoid, "30 D" | ABC | | 28 | Unifocal, aspheric glass lens |
| Selsi Loupe No. 445, 1 ½ inch | S | | 28 | Attached to spectacles |
| B&L Eyeglass Loupe, × 7 | BL | | 27 | Attached to spectacles |
| Policoff, × 7 | P | | 25 | Bifocal insert |
| Volk Conoid, "25 D" | ABC | | 24 | Unifocal, aspheric glass lens |
| A. O. "Microscopic", × 6 | AO | | 24 | Bifocal addition |
| Feinbloom "Microscopic", × 6 | F | | 23 | Unifocal, compound lens |
| Hyperocular, × 6 | ML | | 22 | Unifocal, plastic aspheric lens |
| Keeler Aspheric, × 6 | K | | 22 | Unifocal, with distance control |
| Keeler Bifocal, × 6 | K | 7 M | 22 | Bifocal insert, aspheric plastic lens |
| Policoff, × 5 | P | | 20 | Bifocal insert |
| Volk Conoid, "20 D" | ABC | | 20 | Unifocal, aspheric glass lens |
| B&L Eyeglass Loupe, × 5 | BL | | 19 | Attached to spectacles |
| Continental, × 5 | CO | | 19 | Bifocal addition |
| Keeler "Best Form", × 5 | K | | 19 | Unifocal |
| Selsi Loupe, No. 445, 2 inch | S | | 19 | Attached to spectacles |
| Keeler Bifocal, × 5 | K | | 17 | Bifocal insert, aspheric plastic lens |
| Magnifocuser No. 17 | EP | | 17 | On headband, worn over spectacles |
| Hyperocular, × 4 | ML | | 16 | Unifocal, aspheric plastic lens |
| A. O. "Microscopic", × 4 | AO | | 16 | Bifocal addition |
| Keeler "Best Form", × 4 | K | | 16 | Unifocal |
| Volk Conoid, "15 D" | ABC | | 15 | Unifocal, aspheric glass lens |
| Keeler Bifocal, × 4 | K | | 15 | Bifocal insert, aspheric plastic lens |
| Continental, × 4 | CO | 5 M | 15 | Bifocal addition |
| B&L Eyeglass Loupe, × 4 | BL | | 15 | Attached to spectacles |
| Feinbloom "Microscopic", × 4 | F | | 15 | Unifocal, compound lens |
| Magnifocuser No. 15 | EP | | 15 | On headband, worn over spectacles |
| Selsi Loupe No. 445, 2 ½ inch | S | | 15 | Attached to spectacles |
| Magnifocuser No. 13 | EP | | 13 | On headband, worn over spectacles |
| B&L Eyeglass Loupe, × 3.3 | BL | | 13 | Attached to spectacles |
| Selsi Loupe No. 445, 3 inch | S | | 13 | Attached to spectacles |
| Policoff, × 3 | P | | 12 | Bifocal insert |
| Keeler "Best Form", × 3 | K | | 12 | Unifocal |
| Continental, × 3 | CO | | 12 | Bifocal addition |
| Selsi Loupe No. 445, 3 ½ inch | S | | 12 | Attached to spectacles |
| Keeler Bifocal, × 3 | K | | 11 | Bifocal insert, aspheric plastic lens |
| B&L Eyeglass Loupe, × 3 | BL | 4 M | 11 | Attached to spectacles |
| May Loupe | MM | | 10 | Attached to spectacles |
| Magnifocuser No. 10 | EP | | 10 | On headband, worn over spectacles |
| Selsi Loupe No. 445, 4 inch | S | | 10 | Attached to spectacles |
| Continental, × 2.5 | CO | | 10 | Bifocal addition |
| Conventional spectacles | Local optician | | 10-12 | Unifocal, bifocal, or half glass |

TABLE 1.—*Head-Borne Reading Aids* *—Continued

| Manufacturer's Designation | Source † | $D_e$ and $M_{16}$ Rating ‡ | | Description |
|---|---|---|---|---|
| Keeler "Best Form", × 2 | K | 3 M | 8 | Unifocal |
| A. O. "Microscopic", × 2 | AO | | 8 | Bifocal addition |
| Keeler Bifocal, × 2 | K | | 8 | Bifocal insert, aspheric plastic lens |
| Continental, × 2 | CO | | 8 | Bifocal addition |
| Seiai Loupe No. 445, 5 inch | S | | 8 | Attached to spectacles |
| Conventional spectacles | Local optician | | 8 | Unifocal, bifocal, or half glass |
| Continental, × 1.75 | CO | 2.5 M | 7 | Bifocal addition |
| Conventional spectacles | Local optician | | 7 | Unifocal, bifocal, or half glass |
| Continental, × 1.5 | CO | 2 M | 6 | Bifocal addition |
| Continental, × 1.2 | CO | | 5 | Bifocal addition |
| May Loupe | MM | | 5 | Attached to spectacles |
| Conventional spectacles | Local optician | | 5-6 | Unifocal, bifocal, or half glass |
| Conventional spectacles | Local optician | 1.5 M | 3-4 | Unifocal, bifocal, or half glass |

* Those of the telescopic type are given in Table 2.

† See Table 7.

‡ The ratings 20 M, 14 M, etc., given in this and the following Tables, indicate the approximate acuity (measured at 40 cm. with Sloan Reading Cards) for which each device is suitable. The ratings are based on the assumption that the user is an emmetrope who does not accommodate when using the magnifier.

§ Not a bifocal in the ordinary sense but does provide some far vision outside of spot.

greater than their equivalent focal lengths, ($f_e$).† The values of $f_a$, $f_e$, and the ratio $f_a/f_e$ are given in Columns 5 to 7 of Table 2. This ratio provides an index of the gain in working distance of a telescopic reading aid as compared with a thin lens of the same equivalent power. The ratios for 30 of the 50 devices listed in Table 2 range from 1.5 to 2.7. The Feinbloom Mirrorscope has a ratio of 3.4. The 19 devices with ratios below 1.5 include all of the Barrett Monoculars, all of the Keeler Full Field Magnifiers, and one of the Keeler Bar Type Magnifiers. The Keeler Full Field × 8 Magnifier has, for example, an equivalent focal length of 31 mm., an anterior focal length of 40 mm.; the corresponding focal lengths of the Full Field × 3 Magnifier are 90 and 114 mm. Because of the extra weight and bulk of a compound plus-and-minus lens system, its advantages are questionable when it provides less than a 50% increase in working distance. Data to be presented in the next section will show, on the other hand, that the advantages as regards working distance of a high $f_a/f_e$ ratio are to a certain extent offset by a marked reduction in extent of field.

The increase in size of the retinal image provided by the head-borne type of reading aid bears a very simple relation to its equivalent, or true, power. If the reading material is located in the principal focal plane of the magnifier lens, the size of the image is directly proportional to the equivalent power of the reading aid, $D_e$. Under these conditions the emmetropic eye receives a clearly focused retinal image when accommodation is fully relaxed. An uncorrected myopia or hyperopia can be compensated for by a suitable shift in the reading page from the principal focal plane. The patient who can sustain a significant amount of accommodation can bring the page closer and so obtain a still larger retinal image. In general, if the magnifier lens (assumed to be thin) is located at the anterior principal focus of the eye, the size of the retinal image is proportional to $D_e+A$, where $A$ is the dioptric power contributed by the user either by accommodation or because of an uncorrected spherical ametropia. The dioptric power, $A$, is meas-

† Equivalent powers are specified to the nearest whole diopter in Table 1. In Table 2 they are given to the nearest 0.1 D. so as to agree with the specifications of equivalent focal length given in this Table.

TABLE 2.—*Head-Borne Reading Aids (Telescopic Type)*

| Manufacturer's Designation | Source * | $D_s$ and $M_{ts}$ Rating | | Description | $f_o$, Cm. | $f_e$, Cm. | $f_o/f_e$ |
|---|---|---|---|---|---|---|---|
| DeWohler, 20 D. add | AFB | 20 M | 55.1 | Removable reading cap | 1.8 | 5.0 | 2.7 |
| DeWohler, 15 D. add | AFB | 14 M | 39.2 | Removable reading cap | 2.6 | 7.0 | 2.7 |
| Keeler Bar Type ×10 | K | | 38.8 | Bifocal | 2.6 | 5.3 | 2.1 |
| Seisi Sport Glass, 15 D. add | AFB | 10 M | 34.3 | Removable reading cap | 2.9 | 7.0 | 2.4 |
| Keeler Full Field, × 8 | K | | 32.4 | Unifocal | 3.1 | 4.0 | 1.3 |
| Kollmorgen × 2.2, 14 D. add | KO | | 30.8 | Removable reading cap | 3.3 | 7.0 | 2.2 |
| Keeler Bar Type, × 8 | K | | 29.6 | Bifocal | 3.4 | 7.2 | 2.1 |
| DeWohler, 10 D. add | AFB | | 27.4 | Removable reading cap | 3.7 | 10.0 | 2.7 |
| Kollmorgen × 2.2, 12 D. add | KO | | 26.2 | Removable reading cap | 3.8 | 8.2 | 2.2 |
| Feinbloom Mirrorscope, 7 D. add | F | | 25.8 | Removable reading cap | 3.9 | 13.1 | 3.4 |
| Seisi Sport Glass, 10 D. add | AFB | 7 M | 24.0 | Removable reading cap | 4.2 | 10.0 | 2.4 |
| Keeler Bar Type, × 6 | K | | 23.8 | Bifocal | 4.2 | 9.5 | 2.3 |
| Keeler Full Field, × 6 | K | | 23.1 | Unifocal | 4.3 | 5.4 | 1.25 |
| Kollmorgen × 1.7, 14 D. add | KO | | 22.8 | Removable reading cap | 4.4 | 7.0 | 1.6 |
| Kollmorgen × 2.2 10 D. add | KO | | 21.6 | Removable reading cap | 4.6 | 9.9 | 2.2 |
| Keeler Bar Type, × 5 | K | | 19.9 | Bifocal | 5.1 | 10.6 | 2.1 |
| Kollmorgen × 1.7, 12 D. add | KO | | 19.5 | Removable reading cap | 5.1 | 8.2 | 1.6 |
| Keeler Full Field, × 5 | K | | 19.3 | Unifocal | 5.2 | 6.3 | 1.2 |
| Univis × 2, 10 D. add | UL | | 18.9 | Bifocal | 5.3 | 10.3 | 2.0 |
| Barrett +20/—2 | CP | | 18.8 | Unifocal | 5.3 | 5.5 | 1.04 |
| Barrett +20/—4 | CP | 5 M | 17.6 | Unifocal | 5.7 | 6.15 | 1.08 |
| Kollmorgen × 2.2, 8 D. add | KO | | 16.8 | Removable reading cap | 6.0 | 12.8 | 2.2 |
| Barrett +20/—6 | CP | | 16.4 | Unifocal | 6.1 | 6.8 | 1.12 |
| Kollmorgen × 1.7, 10 D. add | KO | | 16.1 | Removable reading cap | 6.2 | 10.0 | 1.6 |
| DeWohler, 6 D. add | AFB | | 15.9 | Removable reading cap | 6.3 | 17.2 | 2.7 |
| Barrett +20/—8 | CP | | 15.2 | Unifocal | 6.6 | 7.7 | 1.16 |
| Keeler Bar Type, × 4 | K | | 15.2 | Bifocal | 6.6 | 11.3 | 1.7 |
| Univis × 2, 8 D. add | UL | | 15.0 | Bifocal | 6.7 | 13.0 | 2.0 |
| Keeler Full Field, × 4 | K | | 14.8 | Unifocal | 6.7 | 8.3 | 1.2 |
| Univis × 1.5, 10 D. add | UL | | 14.5 | Bifocal | 6.9 | 10.4 | 1.5 |
| Seisi Sport Glass, 6 D. add | AFB | | 14.4 | Removable reading cap | 7.0 | 16.7 | 2.4 |
| Barrett +20/—10 | CP | | 14.0 | Unifocal | 7.15 | 8.6 | 1.20 |
| Barrett +20/—12 | CP | | 12.8 | Unifocal | 7.8 | 9.7 | 1.24 |
| Kollmorgen × 2.2, 6 D. add | KO | | 12.6 | Removable reading cap | 7.9 | 17.0 | 2.2 |
| Kollmorgen × 1.7, 8 D. add | KO | | 12.5 | Removable reading cap | 8.0 | 12.8 | 1.6 |
| Univis × 1.5, 8 D. add | UL | 4 M | 11.6 | Bifocal | 8.6 | 13.0 | 1.5 |
| Barrett +20/—14 | CP | | 11.6 | Unifocal | 8.6 | 11.0 | 1.28 |
| Keeler Bar Type, × 3 | K | | 11.5 | Bifocal | 8.7 | 11.6 | 1.3 |
| Univis × 2, 6 D. add | UL | | 11.3 | Bifocal | 8.9 | 17.2 | 2.0 |
| Keeler Full Field, × 3 | K | | 11.1 | Unifocal | 9.0 | 11.4 | 1.3 |
| Barrett +20/—16 | CP | | 10.4 | Unifocal | 9.6 | 12.7 | 1.32 |
| Kollmorgen × 1.7, 6 D. add | KO | | 9.6 | Removable reading cap | 10.4 | 16.7 | 1.6 |
| Optikon | EP | 3 M | 9.6 | Unifocal | 10.4 | 25.0 | 2.6 |
| Barrett +20/—18 | CP | | 9.2 | Unifocal | 10.9 | 14.8 | 1.36 |
| Aloe Reading Unit | AA | | 9.0 | Removable attachment to spectacles | 11.1 | 13.4 | 1.2 |
| Univis × 1.5, 6 D. add | UL | | 8.8 | Bifocal | 11.4 | 17.1 | 1.5 |
| Barrett +20/—20 | CP | | 8.0 | Unifocal | 12.5 | 17.5 | 1.40 |
| Univis × 2, 4 D. add | UL | | 7.6 | Bifocal | 13.2 | 25.6 | 2.0 |
| Keeler Full Field, × 2 | K | 2.5 M | 7.4 | Unifocal | 13.5 | 15.6 | 1.2 |
| Seisi Sport Glass, 3 D. add | AFB | | 7.2 | Removable reading cap | 13.9 | 33.3 | 2.4 |
| Keeler Full Field, × 1.6 | K | 2 M | 6.1 | Unifocal | 16.4 | 19.1 | 1.2 |
| Univis × 1.5, 4 D. add | UL | | 5.9 | Bifocal | 17.0 | 25.6 | 1.5 |
| Neico Reading Magnifier | NEI | | 5.7 | Removable attachment to spectacles | 17.5 | 22.7 | 1.3 |

* See Table 7.

ured in the anterior focal plane of the eye and is positive for accommodation and for uncorrected myopia, negative for uncorrected hyperopia. For a thick lens system, the size of the retinal image is proportional to $D_e+A$ when the second principal plane of the lens is at the anterior focal plane of the eye and is proportional to $D_e+A-hAD$ when there is a separation, $h$, between the two planes.

To determine the power of the reading aid required by the individual patient we must know how large a retinal image he requires for useful reading. Special reading cards for making such determinations have been described elsewhere.[7,10-12] These cards measure the smallest size of print which the patient can read with ease at a standard testing distance of 40 cm. The print sizes are specified in "M units." The over-all dimensions of 1 M print subtend a 5-minute visual angle at 1 m.; those of 2 M print subtend 5 minutes at 2 m., etc. Since 1 M print corresponds approximately to newsprint in size, the patient who reads this size of print at the usual reading distance of 40 cm. will, as a rule, not require any special reading aid unless he is presbyopic. The presbyope will need only a conventional reading addition of 2.50 D. or less, depending on the accommodation he can sustain. If 4 M print is, for example, the smallest which the patient can read at 40 cm., then to read 1 M print he must hold the page at 10 cm., as shown in Figure 1. If his power of accommodation is negligible he will need 2.50 D. to read at 40 cm., $4\times2.50$, or 10 D., to read at 10 cm. The third column of Table 1 shows, in addition to the dioptric powers, the approximate acuities, measured in M units at 40 cm., for which each of the reading aids is suitable. These ratings are based on the assumption that the user is an emmetrope who does not accommodate when using the magnifier. It is important to remember that it may be possible to prescribe a weaker reading aid when there is an uncorrected myopia or when the emmetropic user can sustain a significant amount of accommodation. A suitable allowance for the accommodation which the patient can sustain is particularly important is prescribing for young children.

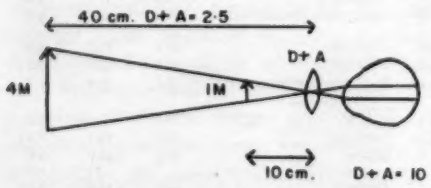



Fig. 1.—Relationship between reading vision, measured in M units at 40 cm., and the dioptric power of the reading aid which permits the patient to read 1 M print.

One of the difficulties in the use of head-borne magnifiers of high power is the fact that very slight changes in the distance of the object produce marked changes in the vergence of the light leaving the lens. The patient with a low amplitude of accommodation must maintain the correct distance more precisely than one who can accommodate for the changing vergence of the light rays. The elderly patient may, therefore, find it hard to read with a Type I magnifier, particularly if arthritis, muscle tremor, or general weakness increases the difficulty of maintaining the reading page at the proper distance from the lens. A second problem is that of obtaining sufficient light on the page when the working distance is short. The only optical aid of Type I which attempts to meet both of these problems is the Keeler Illuminated Spectacle Magnifier.

*Type II. Focusable Stand Magnifiers.*—In this type of reading aid the lens is supported in a mount which rests on the page. The distance of the page from the lens can be varied to suit the individual patient, but, once determined, it is automatically maintained by the lens support. Some of the devices in this group have a built-in source of

Fig. 2.—A group of focusable stand-magnifiers.

illumination. The Keeler Illuminated Spectacle Magnifiers and the Keeler × 8 and × 6 Aspheric Magnifiers, designed for use as head-borne magnifiers of Type I, can also be used as focusable stand magnifiers. These and other devices of Type II are shown in Figure 2.

In order to minimize aberrations and to obtain a wide field of vision the eye should be close to the lens of a Type II magnifier. For long periods of use a reading stand is desirable. As in the case of Type I magnifiers, the patient who can sustain a significant amount of accommodation can get a larger retinal image by bringing the reading page within the principal focal plane of the lens. It is also possible to compensate for uncorrected spherical ametropias by suitable variation of the object-to-lens distance. When the eye is close to the lens (assumed to be thin) of a Type II magnifier, it is optically similar to a Type I device in that the size of the retinal image is proportional to $D_e+A$. Type II magnifiers, however, differ from Type I in that the range over which the object-to-lens distance can be varied is limited, and this in turn limits the amount of ametropia that can be corrected by focusing the magnifier. For example, a small tripod magnifier made in Japan (shown in lower left corner of Fig. 3) can be focused to correct for spherical ametropias varying from 3 D. of hyperopia ($A=-3$) to 8 D. of myopia ($A=+8$). The magnifiers of Type II listed in Table 3 include all of the acceptable commercially available devices of this type that we have been able to locate plus a series of five magnifiers made in our shop. (The five Wilmer focusable stand magnifiers are shown in Fig. 4.) Column 3 of Table 3 gives the equivalent dioptric powers and the level of reading vision (in M units) for which each device is suited. Column 4 gives data on the maximal and minimal values of ametropia for which each can compensate.

*Type III. Hand Magnifiers.*—A third type of reading aid is the well-known hand magnifier, which is not supported in a mount but is held by the user at a suitable distance from the reading page and from the eye. In the higher powers, hand magnifiers are less satisfactory for sustained reading than are focusable stand magnifiers be-

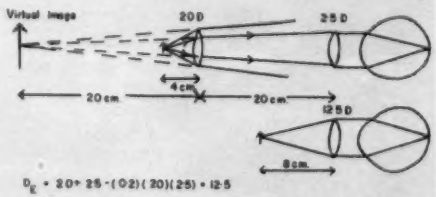



Fig. 3.—The optical characteristics of a fixed-focus magnifier with variable eye-to-lens distance.

TABLE 3.—*Focusable Stand Magnifiers*

| Manufacturer's Designation | Source * | $D_0$ and $M_{15}$ Rating † | Range of Focus: Minimum A | Range of Focus: Maximum A | Comments |
|---|---|---|---|---|---|
| Pitman Challenger, × 20 | HP | 20 M | 77 | >−20 | +13 | |
| Keeler Ill. Spec. Mag., × 20 | K | | 74 | >−20 | +10 | Also Type I |
| Keeler Ill. Spec. Mag., × 15 | K | | 59 | >−20 | >+20 | Also Type I |
| Keeler Ill. Spec. Mag., × 12 | K | 14 M | 47 | −13 | +20 | Also Type I |
| Keeler Ill. Spec. Mag., × 10 | K | | 45 | −12 | >+20 | Also Type I |
| Pre-Cop-Tic No. 20 | AN | | 40 | − 9 | +12 | |
| Wilmer 34 | Experimental | 10 M | 34 | −13 | +10 | See Fig. 4 |
| Pre-Cop-Tic No. 10 | AN | | 32 | − 3 | +17 | |
| Keeler Aspheric × 8 | K | | 30 | − 2.5 | + 3 | Also Type I |
| Tripod Magnifier | AFB | | 30 | − 3 | + 8 | |
| Tripod Magnifier | BL | | 29 | − 3 | + 7 | |
| Wilmer 29 | Experimental | | 29 | − 9.5 | +13.5 | |
| Flawfinder | AFB-EWP | | 29 | − 3 | +13 | |
| Edmonds Comparator | ES | 7 M | 24 | − 0.5 | + 4 | Very small field |
| Utility Magnifier, × 6.5 | ES | | 23 | − 9 | + 4 | Heavy |
| Wilmer 23 | Experimental | | 23 | − 6 | +11 | See Fig. 4 |
| Keeler Aspheric, × 6 | K | | 22 | − 1 | + 4 | Also Type I |
| Utility Magnifier, × 5 | ES | | 18 | − 3 | +10 | Heavy |
| Wilmer 18 | Experimental | | 18 | − 3 | +10 | See Fig. 4 |
| S&A No. 543 Universal | SA | 5 M | 13 | + 2 | +16 | Emmetrope must exert at least 2 D. of accommodation |
| Wilmer 13 | Experimental | | 13 | − 1 | + 9 | See Fig. 4 |
| Edmonds Metal Stand Mag. | ES | 4 M | 10 | + 2 | >+20 | Emmetrope must exert at least 2 D. of accommodation |
| Seibt Stand Reader No. 358, 5 D. | S | 2 M | 5 | − 0.5 | + 3 | Lens on gooseneck support |
| Seibt Stand Reader No. 358, 3 D. | S | 1.5 M | 3 | + 0.5 | + 4 | Lens on gooseneck support |

* See Table 7.
† See footnote, Table 1.

cause of the difficulty in maintaining the lens parallel to the page and at the correct distance. In dioptric powers of 10 or less, on the other hand, stand magnifiers are likely to be large and cumbersome and, therefore, not as satisfactory as a simple hand-held device.

Hand magnifiers are often used with the eye at a considerable distance from the lens. In the special case in which the reading page is in the principal focal plane of the lens, the size of the retinal image is proportional to the equivalent dioptric power of the magnifier and is independent of the eye-to-lens distance. Bringing the eye closer to the lens, though it does not increase the magnification in this special case, reduces aberrations and increases the field

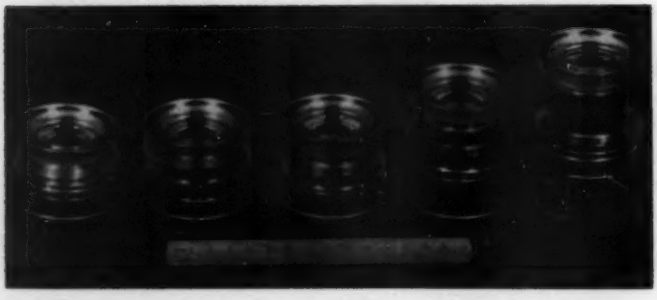


Fig. 4.—Wilmer Institute series of focusable stand magnifiers. Equivalent powers 34, 29, 23, 18, and 13 D.

of view. In the general case in which the page may not be at the principal focus of the lens and the eye may not be close to the lens, the retinal image is proportional to $D'=D_e+A-hAD_e$, where $h$ is the eye-to-lens distance measured in meters and $A$ is, as before, the dioptric power contributed by the user, either by accommodation or by an uncorrected spherical ametropia. $D'$ is also equal to $\frac{1}{u+h-uhD_e}$, where $u$ is the object-to-lens distance and $h$ the eye-to-lens distance, both in meters. When $h$ is 0 or when $u$ equals $f$, the principal focal length of the lens, this formula reduces to $D'=\frac{1}{f_e}=D_e$. Derivations of these formulae are given in previous papers.[10,11] Other formulae for the increase in size of retinal image and its variation with object-to-lens and eye-to-lens distances are given in papers by Laurance,[13] Ellerbrock,[14] and Linksz.[15] The two formulae given here show that the magnification provided by a hand lens can vary enormously according to the way in which it is used by each patient. In order to compare the various hand magnifiers with one another and with those of Type I and Type II we can make the simplifying assumption that the reading page is located in the principal focal plane of the lens so that $u=f$, $A=0$, and the size of the retinal image is, therefore, directly proportional to $D_e$, the equivalent dioptric power. Table 4 lists a number of hand magnifiers in order of dioptric power and gives the values of M acuity for which each is suitable, assuming that $A=0$, i. e., that the user is an emmetropic presbyope.

*Type IV. Stand Magnifiers with Fixed Object-to-Lens Distance.*—This group of magnifiers differs from Type II in that the reading page is at a fixed distance from the lens which is less than its principal focal distance. To obtain a clearly focused retinal image, therefore, the emmetropic user must either exert a certain amount of accommodation or wear reading spectacles. From the optical point of view these magnifiers are more complex and less well understood by some who prescribe them than are the other three types. Magnifiers of Type IV are

TABLE 4.—*Hand Magnifiers*

| Manufacturer's Designation | Source * | $D_e$ and $M_{ea}$ Rating † | | Comments |
|---|---|---|---|---|
| Swift & Anderson No. 572 Triplet, × 20 | SA | 20 M | 61 | |
| B&L Folding Pocket, × 10 | BL | 14 M | 44 | |
| B&L Hastings, × 10 | BL | | 36 | |
| Quizzer, × 10 | K | 10 M | 35 | |
| B&L Coddington, × 10 | BL | | 34 | Illuminated |
| B&L Folding Pocket, × 8 | BL | | 33 | |
| Swift & Anderson No. 574 Doublet, × 10 | SA | | 31 | |
| Quizzer, × 8 | K | | 30 | |
| Swift & Anderson No. 569 Pocket, × 10 | SA | | 29 | |
| B&L Coddington, × 7 | BL | 7 M | 25 | |
| B&L Folding Pocket, × 6 | BL | | 23 | |
| Quizzer, × 6 | K | | 22 | |
| Swift & Anderson Radiant, No 531 | SA | | 19 | Illuminated |
| B&L Folding Pocket, × 5 | BL | | 19 | |
| Quizzer, × 5 | K | | 18 | |
| B&L Octagonal | BL | 5 M | 16 | |
| Quizzer, × 4 | K | | 15.5 | |
| Swift & Anderson No. 569 Pocket, × 5 | SA | | 15 | |
| B&L Double Lens | BL | | 12.5 | Illuminated; stand attachment available |
| B&L Folding Pocket, × 3 | BL | 4 M | 11 | |
| Quizzer, × 2 | K | | 11 | |
| Assorted hand-magnifiers | Local Optician | 3-2 M | 8-5 | |

* See Table 7; † See footnote, Table 1.

of three varieties. Those in the first subgroup are designed for use with the eye close to the magnifier lens so that the field of view will be large and the aberrations minimal. The most generally useful devices in this subgroup (Type IV*a*) are those in which the fixed object-to-lens distance is only slightly less than the principal focal length of the lens, so that not more than 2 or 3 D. of accommodation are required of the emmetrope. If the user cannot sustain the required amount of accommodation, he must either tolerate a blurred image or must treat the device as a hand magnifier (Type III). When used in this way with the lens at its principal focal distance above the reading page, the size of the retinal image is proportional to the equivalent dioptric power, $D_e$. When used as intended, the retinal image is somewhat larger and is proportional to $D'$, where $D'=D_e+A$. $A$ in this equation equals the diopters of accommodation which the emmetropic user must contribute in order to obtain a clearly focused image. The Bausch & Lomb × 5 Aplanat and the Adisco Illuminated Magnifier, examples of the better devices of this particular type, each require about 1.5 D. of accommodation under normal conditions of use by the emmetrope. In some of the more inexpensive magnifiers the fixed object-to-lens distance varies in different samples, and as a result the required accommodation may vary from 0.50 to 4 D. Other such devices measured in our laboratory have been found to require of the emmetrope as much as 10 or 11 D. of accommodation. Table 5 lists values of $D_e$, $A$, and $D'$ for several of the better devices in this subgroup.

In a second subgroup of fixed focus magnifiers (Type IV*b*) the object-to-lens distance is much less than the principal focal length of the lens, so that a virtual image is formed only a short distance behind the lens. These magnifiers are designed for use with the eye at a considerable distance, such that the magnified virtual image of the page is at a normal reading distance of about 40 cm. (16 in.). The amount of accommodation required of the emmetrope will vary with the eye-to-lens distance, $h$. The I-Gard Plastic Stand Magnifiers are examples of this type.

Figure 3 explains the special features of this group of optical aids and shows why, as normally used, they give much less magnification than other devices of the same dioptric power. The magnifier represented in the Figure is a thin 20 D. lens located at a fixed distance of 4 cm. from the reading page. The light leaving the lens has a divergence of 5 D. and forms, therefore, a virtual image of the print 20 cm. behind the lens. The emmetropic presbyope, wearing a +2.50 reading spectacle, obtains a clearly focused retinal image when his eye is 20 cm. from the magnifier lens and is, therefore, 40 cm. from the virtual image formed by the lens. The size of the retinal image is proportional to $D'$, the equivalent power of the combination of magnifier lens and reading spectacle. Since $D'=D_e+A-hAD$,[3] for the case illustrated in Figure 4, $D'=12.50$

TABLE 5.—*Fixed-Focus Magnifiers Used with Eye Close to Lens*

| Manufacturer's Designation | Source * | $D_e$ | $A$ † | $D'_s$ ‡ | $M_{10}$ Rating | Comments |
|---|---|---|---|---|---|---|
| Flash-O-Lens, × 7 | EWP | 25.7 | 4.7 | 30.4 | 10 M | Illuminated |
| Linen Tester No. 561 | SA | 19.2 | 3.6 | 22.8 | 7 M | Folding |
| Adisco Magnifier | AFB | 20.2 | 1.7-2.2 | 21.9-22.4 | 7 M | Illuminated |
| Flash-O-Lens, × 5 | EWP | 18.4 | 3.2 | 21.6 | 7 M | Illuminated |
| B&L Tester | BL | 18.8 | 1.8 | 20.6 | 7 M | Folding |
| B&L × 5 Aplantic | BL | 17.6 | 1.5 | 19.1 | 7 M | Illuminated |

* See Table 7.

† A is numerically equal to the diopters of accommodation required of the emmetrope for a clearly focused retinal image.

‡ Since $h$ is 0, $D'_s=D_e+A$. $D'_s$ is numerically equal to the power of the spectacle lens which gives the same size of retinal image when $A=0$.

$hAD_e$. The retinal image is the same size as would be obtained if the emmetropic presbyope wore a +12.50 reading spectacle and held the page at 8 cm. from the lens so that no accommodation was required. If he wore a reading spectable of 3.50 instead of 2.50, the distance between spectacle lens and magnifier lens would have to be reduced to 8.6 cm. The retinal image would be significantly larger, since in this vase $D'=17.50$.

A more convenient formula [3] applicable to magnifiers with a fixed object-to-lens distance, $u$, less than the principal focal distance is

$$D'=\frac{A}{1-D_e u}.$$

In the magnifier represented in Figure 3.

$$\frac{1}{1-D_e u}=\frac{1}{1-(20)(04)}=5$$

It is easy to show by this formula that when $A=2.50$ $D'=12.50$ and when $A=3.50$ $D'=17.50$. Although the second formula for $D'$ does not contain $h$ explicitly, it must be remembered that for each of these fixed-focus magnifiers there is a maximal usable value of $A$ equal to that required when $h=0$. In the case of the magnifier shown in Figure 3 the user must contribute 5 D. when his eye is close to the magnifier lens ($h=0$). For a clearly focused retinal image, therefore, $A$ for this magnifier cannot exceed 5 D. It is apparent that the size of the retinal image provided by a fixed-focus magnifier of Type IV*b* depends upon the eye-to-lens distance; this is determined by the dioptric power which the user contributes, either by wearing reading spectacles, by accommodation, or because of an uncorrected spherical error of refraction. Devices of this type are particularly useful for those with only slight reduction in visual acuity who do not have to bring the eye close to the magnifier lens. For users who can contribute about 2.50 D. a majority of the magnifiers of Type IV*b* permit the eye to be at a comfortable distance of about 20-30 cm. from the magnifier lens.

In order to compare magnifiers of Type IV*b* with one another and with other types, we have assumed that the user will contribute exactly 2.50 D. Table 6, therefore, gives for each device the value of $D'$ and of $h$, the eye-to-lens distance, when $A=2.50$. The Table also shows the maximal usable value of $A$, i. e., the diopters which must be contributed by the user in the limiting case in which $h$ is 0 and the eye is close to the magnifier lens.

The projection magnifier (Type IV*c*) is a device in which the user views on a nearby

TABLE 6.—*Fixed-Focus Magnifiers with Variable Eye-to-Lens Distance*

| Manufacturer's Designation | Source * | $D_e$ | $D'_e$ for $A=2.5$ † | $M_{cs}$ Rating | Approx. Eye-to-Lens Distance, $h$, for $A=2.5$ | $A$ Required When $h=0$ | Comments |
|---|---|---|---|---|---|---|---|
| Megascope, × 25 | AFB | — | 53 | 20 M | -- | -- | Projected real image |
| Megascope, × 12 | AFB | — | 29 | 10 M | -- | -- | Projected real image |
| AO Proj. Mag., × 5 | AO | — | 12.5 | 5 M | -- | -- | Projected real image |
| Plastic Base Mag., No. 60044 | ES | 21.5 | 11 | 4 M | 25 cm. | 6.7 | |
| Plasta Cat. Reader | AFB ML | 17 | 9 | 3 M | 25 cm. | 6.5 | |
| Stand Reader S474 | ML | 10 | 8 | 3 M | 18 cm. | 4.4 | |
| AO Proj. Mag., × 3 | AO | — | 7.5 | 3 M | -- | -- | Projected real image |
| Stand Reader S472 | ML | 7.3 | 5.3 | 2 M | 24 cm. | 6.7 | |
| Eze-Rede No. 34 | AS | 10 | 4.5 | 1.5 M | 32 cm. | | Cylinder, magnifies in vertical only |
| Widefield | K | 3.6 | 4.5 to 5 | 1.5 M | 12-16 cm. | 4 | Object distance variable within limits |
| Cross Cylinder No. 350 | S | 5 | 4.2 V 4.6 H | 1.5 M | 26 cm. | | |
| Cross Cylinder, S424 | ML | 9.7 | 4 | 1.5 M | 34 cm. | — | Magnifies principally in vertical |
| Plano-convex lens, V8C | AFB | 16 | 4 | 1.5 M | 35 cm. | 21-26 | |
| Eze-Rede No. 14 | AS | 12 | 4 | 1.5 M | 28 cm. | — | Cylinder, magnifies in vertical only |

* See Table 7.

† $D'_e=D_e+A-hAD_e$. $D'_e$ is numerically equal to the power of the spectacle lens required to give the same size of retinal image when $A=0$. See text for fuller explanation.

screen a real image of the reading page. From the optical point of view it can be considered as a reading aid of Type IV to which the formula $D'=\frac{A}{1-Du}$ is applicable. In this special case, $u$ is greater than the principal focal distance. The factor $\frac{1}{1-Du}$ is, therefore, negative, indicating that the real image is inverted. This factor equals $M_p$, the ratio of the projected real image size to the object size. For the × 12 and × 25 Megascopes the actual values of $M_p$ determined by direct measurement are 11.6 and 21.2, respectively. For the ×3 and × 5 projection magnifiers of the American Optical Co. the measured values of $M_p$ are 3.0 and 5.0, respectively.

If the AO × 5 projection magnifier is used by an emmetropic presbyope wearing reading spectacles of +2.50 D., he will view the projected image from a distance of 40 cm. The fivefold increase in the retinal image is the same as would be obtained if he wore a +12.50 reading spectacle and viewed the same print from a distance of 8 cm. If the user could contribute 5 D. instead of 2.50, he would view the screen from a distance of 20 cm. instead of 40 cm. and would receive a retinal image equal in size to that provided by a 25 D. lens worn as a spectacle. In general the formula

$$D'=\frac{A}{1-Du}=M_p \cdot A$$

may be used to compute the "dioptric power," $D'$, of any projection magnifier when viewed from any dioptric distance, $A$. In listing these devices in Table 5 for comparison with optical aids of Type IV*b*, it is again assumed that the user will contribute 2.50 D. of accommodation. Column 5 of the Table gives the values of $M$ acuity for which each is suitable when $A=2.50$ D.

The essential facts to be remembered in prescribing magnifiers of Type IV may be summarized as follows. The real or virtual image viewed by the user of a Type IV magnifier is at some near distance. The presbyope must, therefore, use the magnifier in conjunction with a suitable reading addition. The size of the retinal image is proportional to D' where

$D'=D_e+A-hAD_e=\frac{A}{1-Du}$.

The data given in Tables 1-6 show that the great majority of presently available magnifiers are of the head-borne type. In the range from 19 to 24 D., for example, Table 1 lists six different spectacle magnifiers of the unifocal type and six of the bifocal type. A similar wide choice of head-borne magnifiers is available in other dioptric ranges. Stand magnifiers, though not as numerous, are available in dioptric powers of 18 and greater. In lower powers, however, the choice of such magnifiers is extremely limited. If the patient can contribute at least 2.50 D. and can read 3 M or better at 40 cm., a few devices of Type IV, such as the Plasta Cataract and Plano-Convex magnifiers, are available. For those with slightly poorer vision, who read only 4 M or 5 M at 40 cm., there is a need for additional focusable stand magnifiers in powers ranging from 10 to about 17 D.

## II. Comparative Measurements of Extent of Field Provided by Reading Aids

In evaluating the relative merits of different devices providing the same magnification an important consideration is the diameter of the usable field. Westheimer [16] has derived formulae for the relationships between linear extent of field and such variables as dioptric power of the magnifier, object-to-lens distance, eye-to-lens distance, and lens diameter. Under the simplest conditions, in which a thin lens is close to the eye and the reading page is in the principal focal plane of the lens, the extent of the field is directly proportional to the diameter of the lens and to its focal length.

In the case of actual reading aids of high dioptric power the various aberrations, in particular oblique astigmatism and curvature of the field,[17] are in some cases sufficiently marked to make unusable a peripheral portion of the field. High degrees of curvature of field are particularly disturbing to the presbyope who cannot accommodate for differences in focus between the center

and the edge of the field. It must be remembered, however, that when ordinary printed matter is viewed under high magnification a moderate amount of defective imagery may not interfere with easy recognition of the letters and may indeed be less noticeable to the patient with subnormal vision than to the normal observer. Although it is not an easy matter to decide on just what degree of poor imagery is permissible, magnifiers may be compared with one another as regards field of vision by adopting some arbitrary standard. It is reasonable to assume that letters that are so blurred or distorted as to be almost unrecognizable by a normal observer will be unreadable by a patient with subnormal vision. By this liberal criterion only a few of the magnifiers investigated in this study were judged to have a usable field of view less than the total field.

Our procedure for obtaining comparative ratings of the field of different reading aids was as follows: 1. The test material used to measure the width of field was a line of typed lower case letters of such size that 14 letters cover an extent of 30 mm. The use of actual letters, rather than a millimeter scale, for example, permitted the observer to recognize the special cases in which, by the criterion adopted, the usable field was less than the total visible field. 2. The magnifiers were tested under comparable conditions duplicating as closely as possible those of actual use. The Type I devices were inserted in a light spectacle frame so adjusted that the unifocal or bifocal lens was in the position it would normally occupy in the final glasses. Optical aids of Type II, III, and IV*a* were tested with the eye as close as possible to the magnifier lens. Fixed-focus magnifiers of Type IV*b* were tested with the viewing distance required when $A=2.50$ D. These distances are given in Table 6. In the case of the focusable magnifiers (Types I, II, and III), the reading page was located in the principal focal plane. 3. Every effort was made to maintain a consistent standard as to acceptable clarity of the image. All determinations of extent of field were made by the same observer, an emmetropic presbyope with a very small amplitude of accommodation. Differences in extent of field in devices of the same dioptric power were verified by repeated intercomparisons.

*Results.*—Measurements of the fields of view of different magnifiers are given in Figures 5-9. In the figures the ordinate shows the extent of the field measured by letters of the standard size for which 14 letters equals 30 mm. and 21 letters equals the width of an average newspaper column.

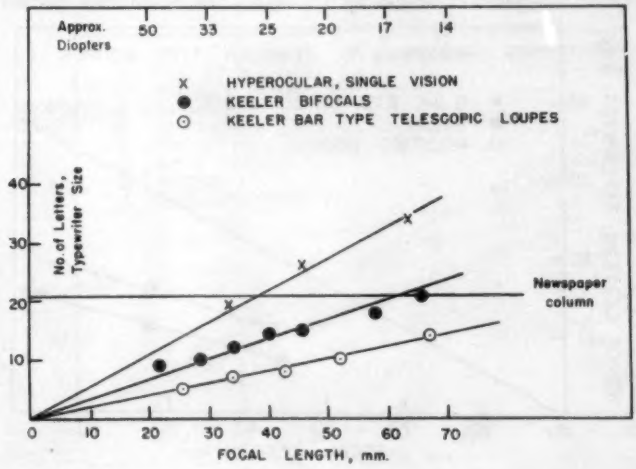



Fig. 5. — Relationship between equilavent focal length and extent of field for three types of spectacle magnifiers.

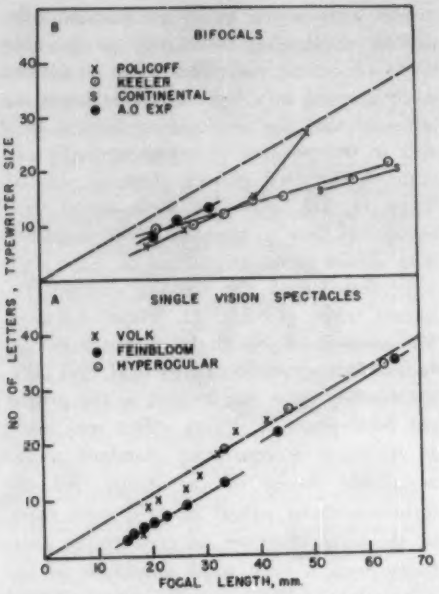



Fig. 6.—Relationship between equivalent focal length and extent of field for a number of spectacle magnifiers. *A*, unifocal type. *B*, bifocal type.

The abscissa shows the equivalent focal length of the magnifier in millimeters. Focal lengths rather than dioptric powers are plotted because in the simplest case in which other factors, such as lens diameter, are constant there is a linear relationship between focal length and diameter of field.

Figure 5 gives illustrative data for three different varieties of spectacle magnifier: (1) a unifocal type, (2) a bifocal type, and (3) a telescopic loupe also of the bifocal type. For each of the three types of magnifiers the plotted data fall on straight lines passing through the origin. The Hyperocular unifocal lenses provide visual fields whose linear extent is about 64% greater than the Keeler telescopic loupes of the bifocal type. Although the bifocal type of magnifier is usually preferable to the unifocal type because distance vision is not entirely cut off, Figure 5 suggests that this advantage may be obtained at the cost of a reduction in the field of vision. Similarly, the advantage of the longer working distance provided by the telescopic loupe may be offset by the smaller fields of vision associated with such devices.

The type of magnifier best suited to the needs of the individual patient will usually be determined by considerations other than extent of field. For any given type, however, it is desirable that the field be as large as possible, particularly when a magnifier of high power is required. Figure 6A gives comparative data for three groups of spectacle magnifiers all of the unifocal type. With certain exceptions each group shows an approximately linear relation between extent of field and focal length. One exception is the Volk "100" aspheric lens with an equivalent power of 56 D. and an equivalent focal length of 18 mm. This is the only one of

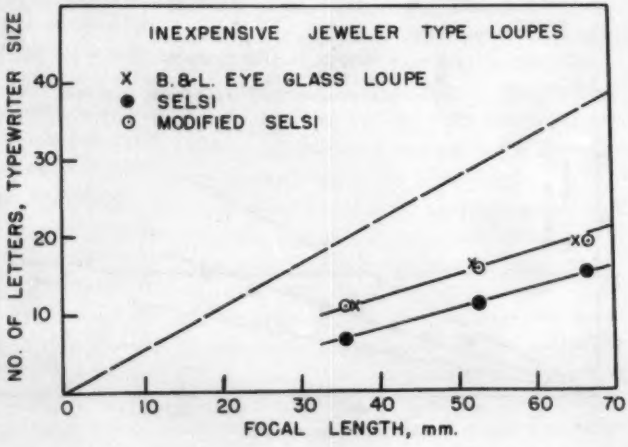



Fig. 7. — Relationship between equivalent focal length and extent of field for two varieties of jeweler's loupes.

the Volk lenses in which, because of aberrations, the usable field was judged to be less than the total. The plotted points for the nine Feinbloom Microscopic Lenses do not fall on a single straight line because the two weakest lenses have wider diameters than the other seven.

The dashed reference line which appears in the Figures shows, on the basis of the Westheimer formula, the theoretical relationship between focal length and extent of field for lenses with a diameter of 30 mm. worn 25 mm. from the center of rotation of the eye. Since none of the reading aids investigated in this study gave visual fields significantly wider than those defined by this reference line, it may be considered to represent the maximal field of vision under the best realizable conditions. From Figure 6A it may be seen that the I-Gard Hyperocular Aspheric lenses and, with one exception, the Volk Conoid lenses have visual fields close to these maximal values. Of the nine Feinbloom lenses seven have fields about 33% less than those of the reference line.

Figure 6B presents data for four groups of bifocal spectacle magnifiers. The Policoff × 5 bifocal, because of its wide diameter, has a field close to the maximal value defined by the reference line. With this one exception the four types of bifocal magnifier do not differ significantly from one another as regards relationship between extent of field and focal length. A comparison of Figures 6A and 6B shows clearly that, in general, unifocal spectacle magnifiers have wider fields of vision than bifocal magnifiers of the same power.

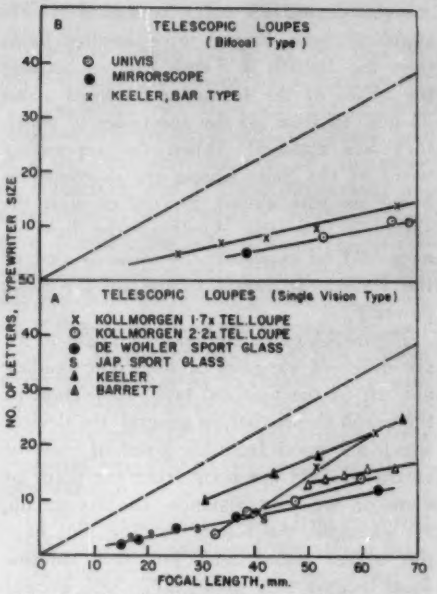



Fig. 8.—Relationship between equivalent focal length and extent of field for a group of telescopic reading aids. *A*, unifocal type. *B*, bifocal type.

Figure 7 gives data for two varieties of inexpensive jeweler's loupes utilizing double

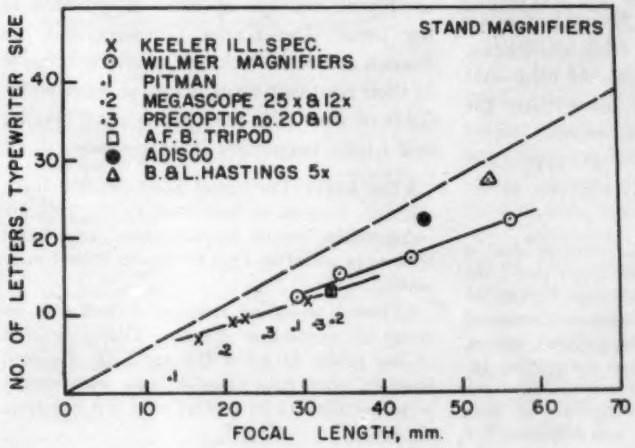



Fig. 9. — Relationship between equivalent focal length and extent of field for a group of stand magnifiers.

convex lenses 25 mm. in diameter. The standard Selsi Loupes give smaller fields than the Bausch & Lomb Loupes because the lenses of the former are located about 23 mm. in front of the spectacles to which they are attached. When the supporting wires of the Selsi Loupe are shortened to bring its lens almost in contact with the spectacle lens, the extent of the field is, as would be expected, the same as that of the Bausch & Lomb Loupe of the same power.‡

Figure 8A gives data on extent of field for six different varieties of telescopic reading aid, all of the unifocal type. Inspection of the graph shows that, in general, the devices which are good from the point of view of extent of field are poor from the point of view of working distance. In this group, for example, the Keeler reading aids have the largest visual fields but have anterior focal lengths only about 20%-30% greater than their equivalent focal lengths (ratios of 1.2 to 1.3). For the two sport glasses, on the other hand, the ratios of anterior to equivalent focal length are 2.4 and 2.7, but the visual fields are very small.

Similar data for several telescopic loupes of the bifocal type are shown in Figure 8B. All of these devices have anterior focal length significantly greater than their equivalent focal lengths. The ratios (given in Column 7 of Table 2) are 1.5 and 2.0 for the Univis loupes, 3.4 for the Feinbloom Mirrorscope, and from 1.7 to 2.2 for the different Keeler Bar Type telescopic loupes. The Keeler loupes have fields of view covering about three letters more than the Univis loupes. The Mirrorscope, tested only with a reading cap of 7 D., appears to be about equal to the Univis loupes as regards extent of field.

‡ For special tasks in which extent of field is not important, an occasional user might prefer the standard to the modified Selsi Loupe because of the slightly increased working distance (measured from the spectacle plane). The modified version, on the other hand, should be best for reading because of the greater number of words seen at one time. This improvement in construction has been brought to the attention of the Selsi Importing Co.

It is well to remember that the nontelescopic bifocal magnifiers previously discussed, i. e., the Policoff, Keeler, American Optical Co., and Continental bifocal reading aids are all cosmetically more pleasing and have visual fields considerably wider than bifocals of the telescopic type. Consequently, unless a longer working distance is an important consideration the telescopic type is at a disadvantage.

Figure 9 presents data for a representative group of stand magnifiers of Types II and IV.§ In this group the devices having visual fields closest to those of the ideal reference line are the Adisco and the Hastings × 5 Magnifier manufactured by Bausch & Lomb. The Selsi Tripod, the Wilmer Institute Magnifiers, and three of the four Keeler Illuminated Magnifiers have visual fields equal to or better than the bifocal spectacle magnifiers of Figure 5. The 74 D. Keeler Illuminated Magnifier has a smaller angular field than the other three, probably because it is the only one whose compound lens can be classed as telescopic, i. e., as composed of convex and concave components.

Figure 10 gives data on the extent of field for representative hand magnifiers of dioptric powers ranging from 18 to 60 D. For comparison with other types of magnifier the extent of field was in every case measured with the eye as close as possible to the lens.‖ The Keeler Quizzers and the Bausch & Lomb Pocket Magnifiers, because of their relatively large diameter, have wider fields of view than the various small doublet and triplet magnifiers in this group.

§ The Keeler Illuminated Spectacle Magnifiers, originally designed as head-borne reading aids, are included here because we and others[7] have found them more useful as Type II than as Type I magnifiers.

‖ There is a marked reduction in field with increase in eye-to-lens distance. Hand-magnifiers of low power (5 to 14 D.) and large diameter, however, often have fields of view wide enough to permit them to be held at some distance from the eye.

TABLE 7.—*Sources of Supply for Magnifiers Listed in Tables 1-6*

| Source of Supply | Code |
|---|---|
| Albert S. Aloe Co.<br>805 Locust St.<br>St. Louis 1 | AA |
| American Foundation for the Blind<br>15 W. 16th St.<br>New York 11 | AFB |
| American Bifocal Co., Inc.<br>1440 St. Clair Ave.<br>Cleveland 14 | ABC |
| American Optical Co.<br>Southbridge, Mass. | AO |
| Anchor Optical Co.<br>P. O. Box 147<br>Audubon, N. J. | AN |
| Apex Specialties Co.<br>115 Douglas Ave.<br>Providence, R. I. | AS |
| Barclay Distributors<br>Box 45<br>Forest Hills, N. J. | BD |
| Bausch & Lomb Optical Co.<br>Rochester, N. Y. | BL |
| Continental Optical Co.<br>1402 N. Capitol Ave.<br>Indianapolis 6 | CO |
| Edmonds Scientific Corp.<br>Barrington, N. J. | ES |
| Edroy Products Co.<br>480 Lexington Ave.<br>New York 17 | EP |
| Dr. William Feinbloom<br>130 E. 74th St.<br>New York 21 | F |
| House of Vision<br>30 N. Michigan Ave.<br>Chicago | HV |
| Keeler Optical Co.<br>5241 Whitby St.<br>Philadelphia 43 | K |
| Kollmorgen Optical Co.<br>Northhampton, Mass. | KO |
| May Manufacturing Co.<br>32-38 62d St.<br>Woodside 77, L. I., N. Y. | MM |
| McLeod Optical Co.<br>357 Westminster St.<br>Providence, R. I. | ML |
| National Electrical Instrument Co.<br>92-21 Corona Ave.<br>Elmhurst, N. Y. | NEI |
| New Era Optical Co.<br>17 N. Wabash Ave.<br>Chicago 90 | NE |
| Harold M. Pitman Co.<br>515 Secaucus Rd.<br>Secaucus, N. J. | HP |
| Policoff Laboratories<br>68 S. Franklin St.<br>Wilkes-Barre, Pa. | P |
| E. W. Pike Co., Inc.<br>429 North Ave.<br>Elizabeth 3, N. J. | EWP |
| Selsi Importing Co.<br>29 E. 22d St.<br>New York 11 | S |
| Swift & Anderson<br>952 Dorchester Ave.<br>Boston 25 | SA |
| Univis Lens Co.<br>Dayton 1, Ohio | UL |

## III. Indications for Further Study

We have shown previously [10,11] that the required dioptric power of a reading aid can be determined from (*a*) the patient's visual acuity measured with continuous text at a standard near distance, (*b*) his error of refraction, and (*c*) the diopters of accommodation he can sustain. In the simplest case in which the patient is an emmetrope with negligible power of accommodation, the power of the reading glass depends only on the size of the print needed for easy reading. In a later report we will present experimental data as to the accuracy with which the dioptric power needed for reading can be predicted from the patient's error of refraction, acuity, and amplitude of accommodation.

Elimination of unnecessary trial and error in selection of the required strength of magnifier allows more time for comparison of different types. It is apparent from the data presented in previous sections of this paper that the necessary increase in size of the retinal image can be obtained in a number of different ways. To simplify the equipment and procedure it is desirable to choose for the subnormal-vision clinic the minimal number of devices which meet the diversified needs of the patients. The literature on the clinical use of reading aids provides very little in the way of experimental evidence as to the relative merits of different types of reading aids.

A survey [9] by the New York Industrial Home for the Blind reports that, of the 351 reading aids prescribed, 208 were spectacles of the unifocal type, 82 were bifocals, and only 61 were telescopic loupes. In Fonda's study [3] a total of 184 patients were given reading aids consisting of either a simple or a compound lens worn in a spectacle frame. Only one of these was of telescopic form. No data are given as to the relative proportions of unifocal and bifocal corrections. Since neither of these studies mention stand or hand magnifiers, it may be inferred that only head-borne reading aids were tried. In contrast to these reports,

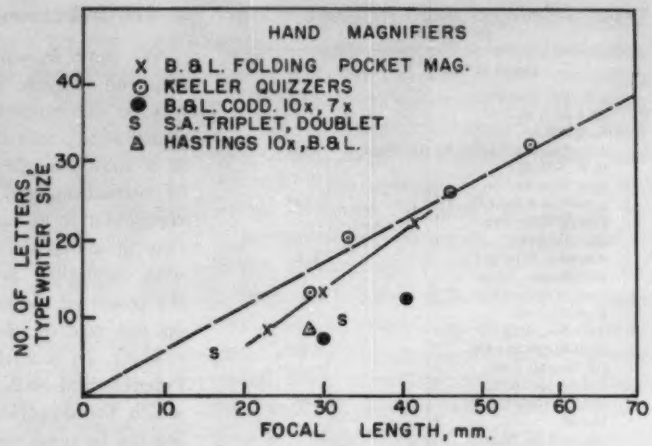



Fig. 10. — Relationship between equivalent focal length and extent of field for a group of hand magnifiers. (These measurements apply to the special case in which the eye is close to the lens.)

those of Gordon and Ritter[1] and Tillett[7] emphasize the advantages of stand and hand magnifiers in comparison with those worn as spectacles. Neither of these papers, however, gives data as to the relative frequency with which the different varieties of reading aid were prescribed. A comparison of the various studies suggests that the type of reading aid given to the patient is generally determined more by the preconceived ideas of the examiner as to which is best than by the patient's requirements and wishes. Further experimental investigation is, therefore, needed to provide an unbiased evaluation of the relative merits of different types. Specifications of the dioptric powers and of the other optical characteristics of the reading aids such as are presented in this paper are a prerequisite for such comparisons. Some of the questions to which answers should be sought are as follows: 1. What proportion of patients, when allowed to compare both types, reject head-borne magnifiers and choose illuminated or nonilluminated stand magnifiers? What are the special factors which influence the choice? Does it depend for example upon the age of the patient, the time spent in learning proper use of the magnifier, the level of acuity, some special feature of the near vision task, etc.? 2. In those cases in which a head-borne device is preferred to a stand magnifier, what proportion of patients choose the bifocal type because they require some distance vision for orientation? In a monocular reading aid how often is the unifocal type preferred because of its wider field, when the other eye can be used for distance vision? Do abnormalities of fixation, such as nystagmus and eccentric and unsteady fixation play a role in determining the importance of a wide field of view? 3. Under what conditions do the advantages of increased working distance outweigh the disadvantages of the telescopic loupe (limited field, weight, poor cosmetic appearance, etc.)? To what extend does the dioptric power of the reading aid determine whether the telescopic type is preferred? 4. What proportion of patients require a magnifier provided with its own source of illumination? Are any specific ocular diseases or abnormalities associated with the need for high illumination?

When answers to these and similar questions have been obtained, it should be possible to outline requirements for the ideal assortment of reading aids covering all of the needed powers and types. In the case of head-borne and hand held reading aids the manufacturer should specify (*a*) either the equivalent dioptric power or the equivalent focal length, (*b*) the anterior focal length or other indication of the maximal

working distance, and ($c$) the linear width of field at this maximal distance. The specifications of focusable stand magnifiers should include, in addition to the above items, the range of spherical ametropia for which each device can compensate. Adequate specifications of the optical characteristics of fixed focus magnifiers, such as those given in Tables 5 and 6 of this paper, can be computed from the equivalent power and the object distance (measured from the principal plane). If a complete assortment of adequately specified reading aids and of accessory devices, such as reading stands and occluders, could be obtained from a single manufacturer, greater interest might be shown in this relatively neglected field of ophthalmology.

## Summary

This paper classifies more than 200 reading aids according to type and reports measurements of equivalent dioptric power, extent of useful field of vision, and other pertinent optical characteristics of each. These data provide a valid basis for comparison of the relative merits of different devices, all of which give essentially the same increase in size of the retinal image.

Wilmer Institute, The Johns Hopkins Hospital (5).

## REFERENCES

1. Gordon, D. M., and Ritter, C.: Magnification, A. M. A. Arch. Ophth. 54:704-716, 1955.

2. Levi, G. A., and King, J. H., Jr.: Evaluation of Certain Optical Devices in the Correction of Subnormal Vision, Am. J. Ophth. 40:29-34, 1955.

3. Fonda, G.: Report of 500 Patients Examined for Low Vision, A. M. A. Arch. Ophth. 56:171-175, 1956.

4. Kestenbaum, A., and Sturman, R. M.: Reading Glasses for Patients with Very Poor Vision, A. M. A. Arch. Ophth. 56:451-469, 1956.

5. Lebensohn, J. E.: Optical Aids for Subnormal Vision, Sight-Saving Rev. 26:201-209, 1956.

6. Stimson, R. L.: Optical Aids for Low Acuity, Los Angeles, Braille Institute of America, 1957.

7. Tillett, C. W.: Visual Aids in Office Practice, Am. J. Ophth. 46:186-194, 1958.

8. Courlander, P.: Optical Appliances for the Partially-Sighted, Brit. J. Physiol. Optics. 15:166-177, 1958.

9. I. H. B. Optical Aids Service Survey: First 500 Cases, The Industrial Home for the Blind, Brooklyn, 1957.

10. Sloan, L. L., and Habel, A.: Reading Aids for the Partially Blind, Am. J. Ophth. 42:863-872, 1956.

11. Sloan, L. L., and Habel, A.: New Methods of Rating and Prescribing Magnifiers for the Partially Blind, J. Optic. Soc. America 47:719-726, 1957.

12. Kasik, M.: Evaluation of the AO Projection Magnifier and Its Use with Partially Sighted Children, Optometric Week. pp. 1145-1148 (June 18) 1958.

13. Laurance, L.: Visual Optics and Sight Testing, London, The School of Optics, Ltd., 1926, p. 448.

14. Ellerbrock, V. J.: Magnification for Near Vision, Am. J. Optom. 31:67-77, 1954.

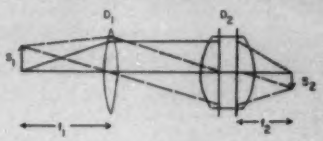
15. Linksz, A.: Optical Principles of Loupe Magnification, Am. J. Ophth. 40:831-840, 1955.

16. Westheimer, G.: The Field of View of Visual Aids, Am. J. Optom. 34:430-438, 1957.

17. Bechtold, E. W.: An Improved System of Wide-Angle Magnifying Spectacles, Optical J. & Rev. Optom. 40:35-40, 1953.

## Appendix

### Determination of True or Equivalent Power of Any Lens by Means of an Optics Bench




$$\frac{s_1}{s_2} = \frac{f_1}{f_2} = \frac{D_2}{D_1} \qquad D_2 = \frac{s_1}{s_2} D_1 = \frac{k}{s_2}$$

Fig. 11.—Measurement of equivalent dioptric power by means of an optics bench.

Figure 11 explains the measurement of equivalent dioptric power by means of an optics bench. A reticle of known size, $s_1$, is located in the principal focal plane of the collimator lens $D_1$. $D_2$ is the unknown lens whose dioptric power is to be determined. A micrometer is used to measure $s_2$, the image of $s_1$ formed in the principal focal plane of $D_2$. If the distances $f_1$ and $f_2$ are measured from the principal focal planes of the lenses $D_1$ and $D_2$ then

$$\frac{s_1}{s_2} = \frac{f_1}{f_2} = \frac{D_2}{D_1}$$

where $D_1$ and $D_2$ are the true, or equivalent, dioptric powers.

$$D_2 = \frac{D_1 s_1}{s_2} = \frac{k}{s_2}$$

when $k$ is a constant for a given reticle and a given lens $D_1$.

When the lens $D_2$ is in actual use as a simple magnifier, the object $s_2$ is generally located in the principal focal plane of the lens. In this case we can think of $D_1$ in the Figure as representing the dioptric system of the eye, $s_1$ as the retinal image of the object $s_2$. The size of the retinal image $s_1 = \frac{s_2 D_2}{D_1}$ It is, therefore, directly proportional to $D_2$ for a given size of object and given dioptric power of the eye. Note that the focal length $f_2$ which determines the size of the image $s_1$ is the true, or equivalent, focal length, not the back or vertex focal length commonly used in specifying the powers of ophthalmic lenses.

# Application of Television Ophthalmoscope to Some Problems of Clinical Ophthalmology

ALBERT M. POTTS, M.D.; SEYMOUR S. WEST, B.E.E., and JOHN R. SHEARER, Cleveland

The television ophthalmoscope is no longer a new instrument; the first such device was demonstrated by Ridley nearly 10 years ago.[1] Nor is the idea of ophthalmoscopy with restricted wave lengths a novel concept. The extensive investigations of Vogt with "red-free light" [2] and the later work of Kugelberg [3] and Kornerup [4] utilizing photography or a photomultiplier tube have explored some of the qualitative aspects of this approach. However, the combination of television ophthalmoscopy and monochromatic illumination offers unique and hitherto unexploited possibilities for new findings particularly when the line-selector technique (*vide infra*) is used to obtain quantitative data. The details of equipment and procedure for such determinations together with some preliminary results are contained in the present paper.

Submitted for publication June 2, 1959.

Read before the Section on Ophthalmology at the 108th Annual Meeting of the American Medical Association, Atlantic City, N. J., June 10, 1959.

From the Laboratory for Research in Ophthalmology and the Department of Anatomy, Western Reserve University, and the Ophthalmology Service, University Hospitals of Cleveland.

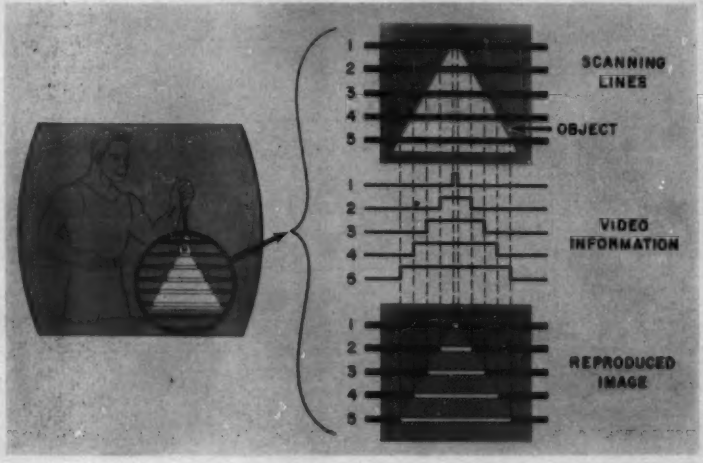
This work was supported in part by a grant from the National Institute for Arthritis and Metabolic Diseases (A-2301). An early phase of this research was supported in part by a grant from the Diabetes Association of Greater Cleveland and the Cleveland Diabetic Fund.

## A. Principles of Operation

A detailed description of the scanning process and of line selection is given in the Appendix, Part I.

The television camera tube, the Image Orthicon, treats the picture focused upon its face by the camera lens as a series of horizontal lines. Each of these lines is composed of dark spots and bright spots corresponding to darker and brighter areas of the original picture. This is illustrated

Fig. 1.—The scanning process.



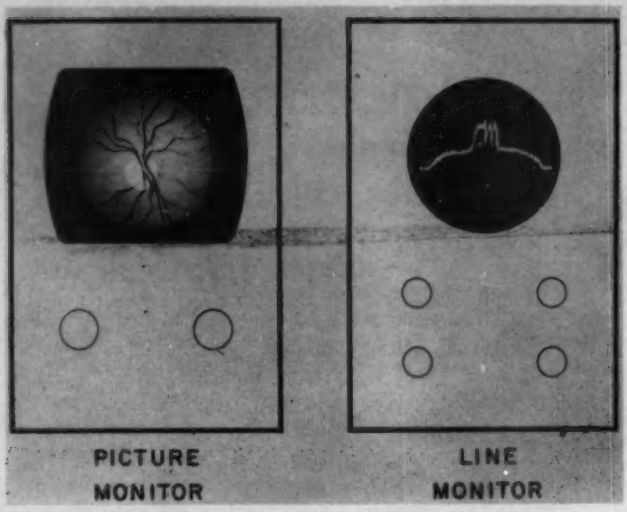


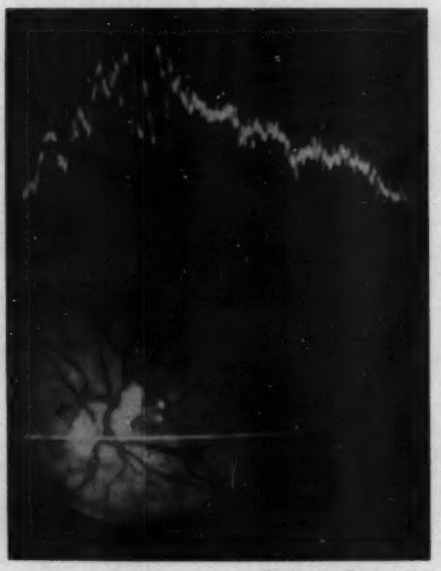

Fig. 2.—Picture monitor and line monitor.

schematically in Figure 1, where a magnified portion of five scanning lines is illustrated. The information about the sequence of darkness and brightness in each line is converted by the scanning process to an electrical signal (video information) and transmitted to the television receiver. Here the video information is reconverted to brightness; when the lines are reproduced in proper sequence on the screen of the receiver, the picture is reproduced in its entirety (reproduced image).

It is possible to select any single line from the television picture and to display this line on a cathode ray oscilloscope. If one allows the brightness information in the video signal to control the *height* of the oscilloscope trace, then one has a line which at the bright spots rises above the base line (representing black), and the brighter the spot the higher the rise.

If an image of the fundus oculi is viewed in this manner, a line may be selected which runs through an anatomical feature of interest or through a pathological lesion. Figure 2 is a simplified diagram showing the monitor of the television ophthalmoscope and the line-selector monitor in operation. The television line which has been selected for individual display and analysis on the line selector is indicated on the picture monitor by the horizontal line passing through the optic disc. Note that the line on the line-selector monitor rises vertically when passing through the disc because of its brightness and that the blood vessels in the central area of the disc cause downward excursions of the line because they are less bright. The *amount* of vertical deflection

Fig. 3.—Photograph of line selected through the disc.



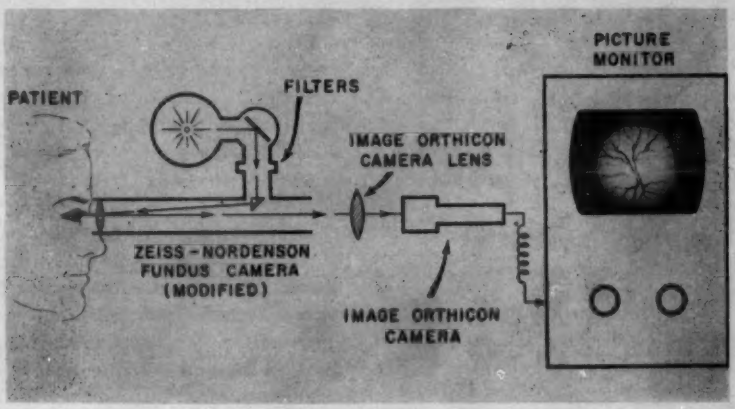



Fig. 4.—Major components of apparatus.

of the line is proportional to the degree of brightness of the corresponding portion of the optical image. Figure 3 shows an actual photograph of the television screen where a line running through the disc has been selected.

If, further, the light used for illumination is monochromatic the amount of light sent into the instrument from any given eye region is a measure of the reflection-absorption (Section C below) of that region for the wave length used. If a series of determinations are made at regularly spaced wave lengths, one may arrive at a spectrogram which may be expected to be typical of the item under observation.

### B. Apparatus

A diagram of the major components of the apparatus is shown in Figure 4.

The fundus of the subject (with dilated pupil) is imaged by a modified Zeiss-Nordenson fundus camera on the modified RCA field-pickup television camera. Monochromatic illumination is obtained with interference filters. The selected line is displayed on a Tektronix cathode ray oscilloscope (not shown). The fundus image on the TV monitor and the oscilloscope trace on the line selector are photographed simultaneously by a single lens reflex 35 mm. camera. The process is repeated for each wave length of interest.

A detailed description of the apparatus is given in the Appendix, Part II.

### C. Interpretation of Data

The factors which determine the exact nature of the light reflected back from the fundus are very complex. For absolute values one will have to take into account the slight but real absorption of cornea, lens, and vitreous. For relative results this may be disregarded, but the remaining considerations are complex enough. One must visualize light passing through the transparent inner retinal layers, through the absorbing visual-cell layer and the translucent retinal pigment epithelium whose density will vary with the genetic make-up of the subject. The light then penetrates the blood-rich and pigmented choroid to be reflected back from the white sclera and must pass again through the layers enumerated above before reaching the ophthalmoscope.

For these reasons the effect of different lesions on reflected light will vary with their nature and position in the retina. A white-appearing lesion caused by destruction of all layers overlying the sclera will eliminate the two-way absorption of photopigment, melanin, and blood and reflect back all light reaching sclera. An opaque white lesion in an inner retinal layer will reflect back light before it reaches even the

visual cells and will in a different way eliminate the contribution of the outer layers. Since the chemical composition of such a lesion will certainly differ from that of sclera, it may be expected that the light reflected back from it will also differ in a measurable way. A third possibility is that of a translucent lesion in an inner layer which reflects back much of the light incident upon it but which transmits some light reflected by sclera through blood and pigment. Comparable considerations apply to pigmented fundus lesions, and, in addition, the absorption, transmission, and reflection of the pigment in the lesion must be taken into account.

The analysis of the data produced by the line selector is complicated by the characteristics of the Image Orthicon camera tube. This component is nonlinear in two respects. First, its output does not vary linearly as the light intensity is varied. Second, its sensitivity to light varies with the wave length of the light that is used. In order to calibrate the instrument for the nonlinear characteristics, a schematic eye containing a diffusely reflecting white disc instead of a retinal reproduction is substituted for the human eye. The use of the schematic eye instead of the white disc alone keeps the optical system roughly unchanged. A series of neutral density filters of known value is inserted between the light source and the ophthalmoscope optics, and the response of the instrument at each light level is recorded. The procedure is repeated at each wave length utilized. It has been found convenient to employ multiple exposures and to record all the responses at a given wave length on a single frame of film. The resulting records permit the plotting of a calibration curve which compensates for intensity response and wave length response of the camera tube. Figure 5 shows both the photographically recorded data and the resulting calibration curve. The ordinate of the curve has been plotted in percentage reflectance rather than reflectance density, since the line-selector monitor is a linear instrument. The calibration curve shown is

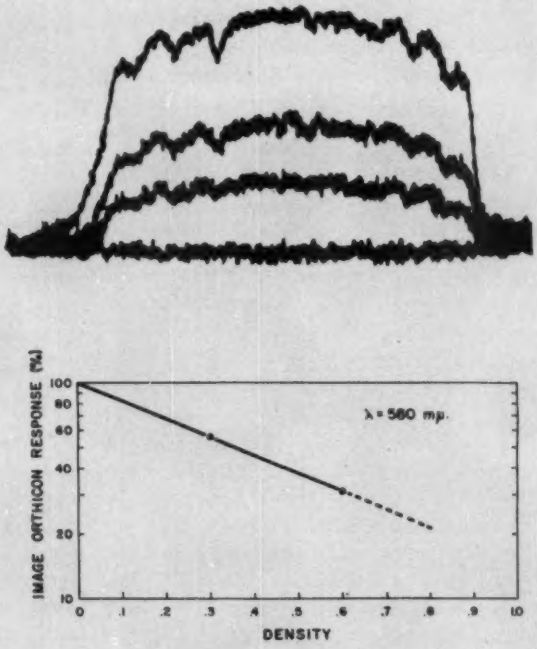
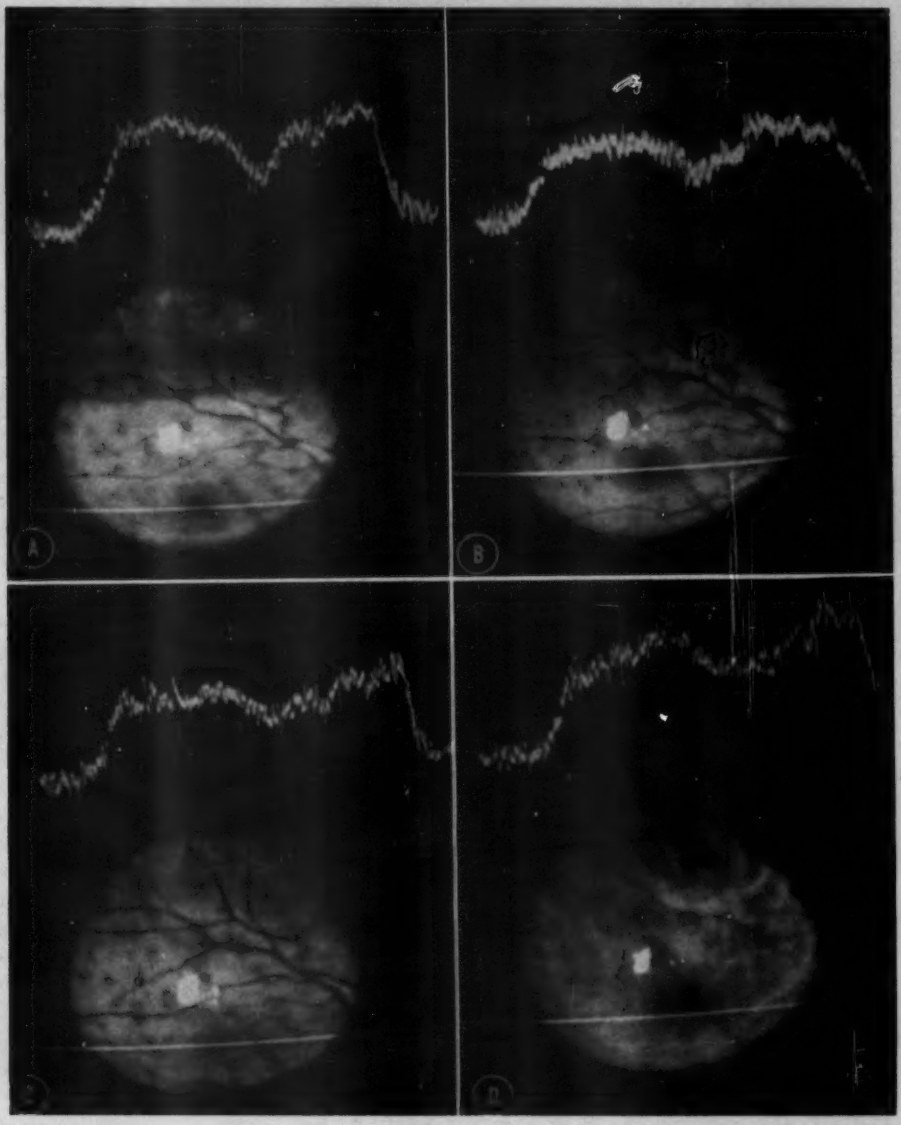



Fig. 5.—Response of Image Orthicon at 580 mμ and calibration curve.

marked for use at a wave length of 580 mμ only. A separate calibration curve is plotted for each wave length at which the instrument is used.

The straight line calibration curve is only obtained when the Image Orthicon camera tube is subjected to low levels of illumination. At high levels of illumination, the camera tube response becomes much more nonlinear and a straight line calibration curve is no longer obtained. Therefore, throughout the course of this work illumination levels were kept low. However, even in the region of illumination where a

Fig. 6.—Television records of normal fundus at four different wave lengths Case 1: *A*, 507 mμ; *B*, 517 mμ; *C*, 555 mμ; *D*, 650 mμ.



straight line is obtained, the slope of this line will vary considerably: hence, the need for a separate calibration curve at each wave length.

In practice, the point to be measured on the line-selected trace is located by referring to the area of interest in the accompanying photograph of the television picture monitor. The vertical excursion of the trace produced by a portion of the retina which appears to be normal and of average reflectance is then measured. The vertical excursions of the trace produced by other features of interest are similarly measured and expressed as a percentage of the excursion produced by the normal retinal area. Each percentage so obtained is used to enter the calibration curve on the left, and the corresponding density is read on the abscissa. These densities are finally plotted as a function of wave length to produce the "reflection" spectrograms discussed below.

## Results

Pertinent details of the case histories of the patients reported on below may be found in the Appendix, Part III.

Much qualitative information may be had from simple inspection of the photographs of the television monitor at various wave lengths. For purposes of orientation it should be remembered that the television ophthalmoscope is an indirect one, and it produces an inverted image. Looking at the fundus of the normal subject (Case 1, Fig. 6) one may see how at the blue end of the spectrum the details of the central area are brought into high contrast. Compare this to the central area of the fundus photograph in Figure 7.

The central declivity can be seen to be dark through a wide range of wave lengths. This is because the darkness of this area is due to its action as a concave mirror (not reflecting light back to the source). However, at the extreme red end, where the retina no longer acts as a reflector and is completely transparent, this central declivity is no longer a striking feature. The yellow

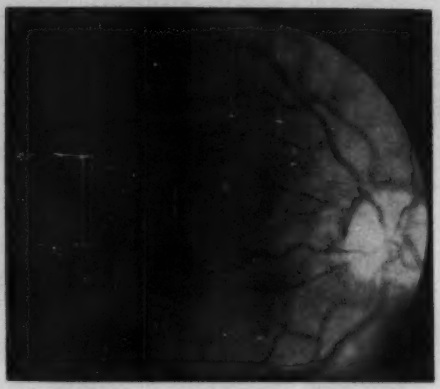


Fig. 7.—Fundus photograph of normal subject, Case 1. Printed from an Ektachrome positive transparency.

pigment of the macula can be seen as a still darker small central area within the central declivity in the short wave length photographs (Fig. 6*A*). This area, seen with difficulty by Vogt's technique and not at all with the unsatisfactory filters on present-day hand ophthalmoscopes, can be easily studied with the television instrument.

The retinal blood vessels show the greatest contrast in the green, where hemoglobin has strong absorption. The picture at 517 mμ (Fig. 6*B*) shows good vascular detail. As one moves toward the long wave length end of the spectrum, hemoglobin absorption decreases so that the retinal vessels become less and less prominent, and at 650 mμ they have practically disappeared (Fig. 6*D*). Conversely, the thicker pigmented layers are most visible at the longer wave length. The thin layer of retinal pigment epithelium is penetrated by these rays, but the thicker layers of choroidal pigment block them and consequently details of choroidal pigmentation which cannot be seen at short wave lengths now become evident (Fig. 6*D*).

Some of these aspects are demonstrated even more emphatically in the cases of eye disease presented here. In Case 2 (Fig. 8) the macular hole reveals choroidal blood behind it, and the view at 555 mμ (Fig. 8*A*) shows this choroidal blood, as well as the rest of the retinal circulation, very clearly

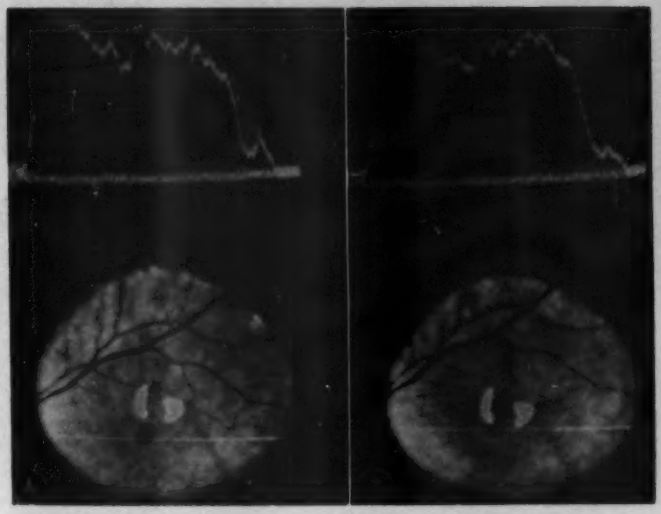
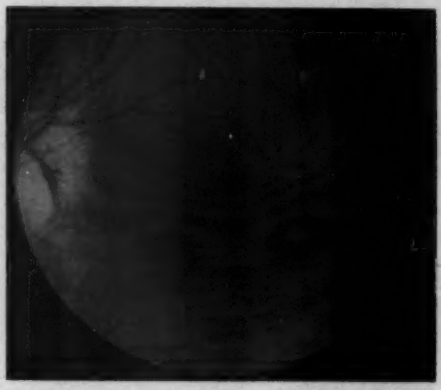


Fig. 8.—Television records of Case 2. Macular hole. *A*, 555 mμ; *B*, 580 mμ.

In the pictures made at longer wave lengths, such as 580 mμ (Fig. 8*B*), the blood is much less in evidence; one is able to see with greater detail the ring of choroidal pigment which surrounds the area of the lesion and which undoubtedly represents a mild inflammatory reaction in that area.

In the case of Patient 3 (Fig. 10) these effects are even more striking. The view at 535 mμ shows the diseased area below the macula (Fig. 10*A*). It must be recalled that with use of the indirect ophthalmoscope of our apparatus one is dealing with an inverted image, and the area appears above the macula in the photograph. In these pictures one sees the area of hemorrhage surrounding the inferior temporal arteriole. This picture is entirely changed in the view at 680 mμ (Fig. 10*B*). The superficial blood is no longer visible at all, the areas of choroidal pigmentation are very prominent, and in the area under consideration a much greater amount of dark pigmented material exists. What this material may represent is subject to some conjecture. If the blood in a deep hemorrhage is thick and, in addition, if much of it has become altered to a substance that has an absorption spectrum other than that of hemoglobin, then this dark mass may indeed be only secondary to hemorrhage, although not blood itself. If, however, a pigmented tumor underlay the hemorrhagic area, it should appear extremely dense, too. One might well have here a powerful method for early demonstration of a pigmented tumor. In actual fact, a second series of pictures made on this patient (Fig. 12) shows the dense area observed at 680 mμ to have decreased markedly in size and density over a period of four weeks (Fig. 12*B*). Consequently, in this case one must assume that one is dealing with conversion products of blood pigment. If the mass were to remain the

Fig. 9.—Fundus photograph of Case 2, from Ektachrome positive transparency.



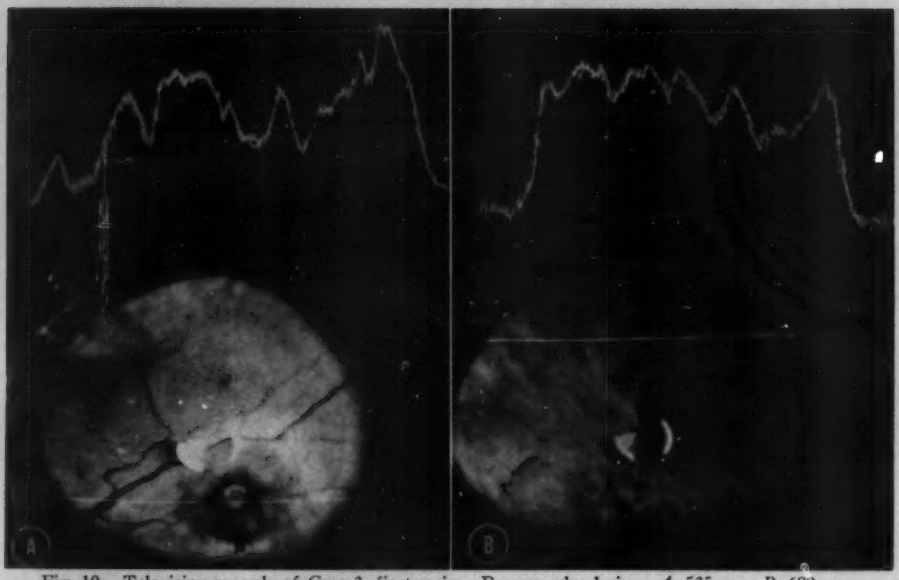


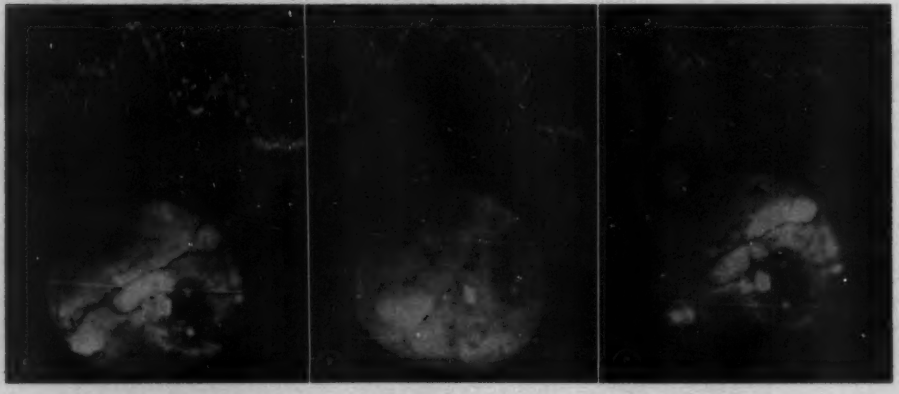
Fig. 10.—Television records of Case 3, first series. Paramacular lesion. *A*, 535 mμ; *B*, 680 mμ.

Fig. 11.—Fundus photograph of Case 3, first examination. Paramacular lesion.

same size or to be slightly enlarged, one would have to consider the alternative diagnosis of melanoma seriously. In addition, this patient now shows a macular star figure well seen at 535 mμ (Fig. 12*A*). The reflectivity at the fovea is well shown on the trace of the selected line (Fig. 12*C*).

The examination of Case 4 was originally undertaken to show an additional type of macular lesion—posthemorrhagic destruction of central area. However, there is an equally important qualitative finding brought out by these records. The record at 535 mμ (Fig. 14*A*) and the fundus pho-

Fig. 12.—Television records of Case 3, second series. Paramacular lesion and macular star figure. *A*, 535 mμ; *B*, 680 mμ; *C*, 535 mμ foveal lesion.



tograph (Fig. 15) show a retinal fold along the course of the inferior (above macula in TV records) temporal vessels. The 680 mμ wave length (Fig. 14*B*) cuts through this fold and reveals a tortuous series of choroidal vessels lying beneath it and hitherto invisible.

The records of Case 5 show still another macular lesion at two wave lengths, 535 and 680 mμ (Figs. 16 and 17) and show how this isolated central "exudate" shows a different relative brightness at the two spectral regions.

In all the foregoing, conclusions were drawn simply from inspection of the tele-

Fig. 13.—Fundus photograph of Case 3, second examination. Paramacular lesion and macular star figure.

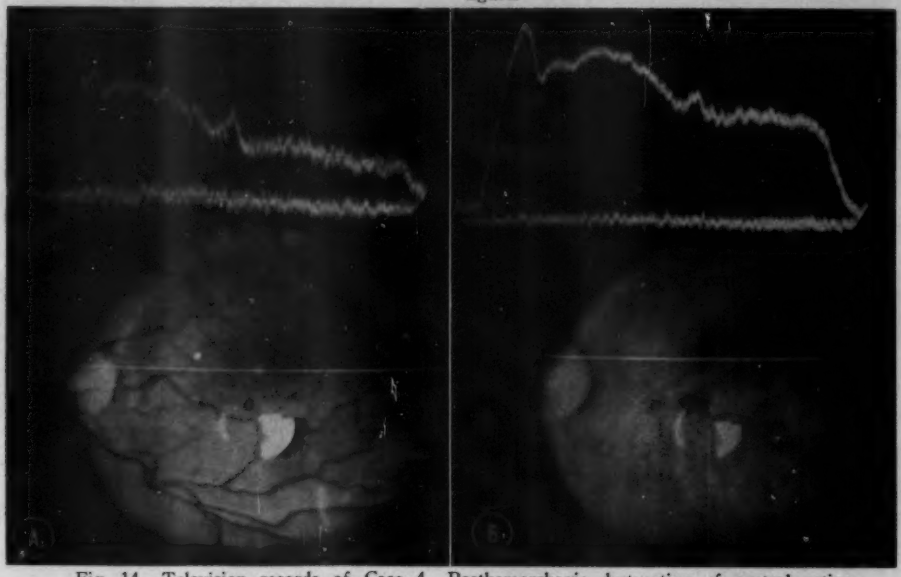
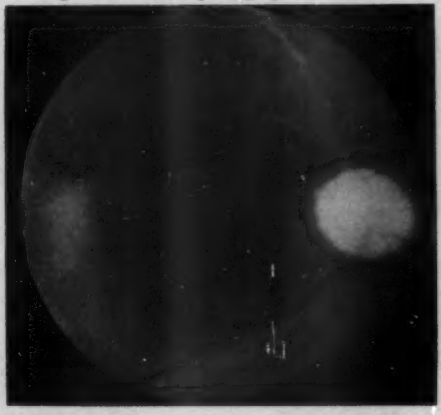


Fig. 14.—Television records of Case 4. Posthemorrhagic destruction of central retina. *A*, 535 mμ; *B*, 680 mμ.

Fig. 15.—Fundus photograph of Case 4.



vision records. In addition, the intensity of reflection-absorption of any given spot on the selected line may be measured on the record, converted to density by use of the calibration chart, and the change with wave length plotted as described in the previous section. Values are expressed in relative terms because of the problems involved in absolute measurements.

For the normal retina in Case 1, we compared density of macula or fovea in relation to a neutral point on the retina. The resultant graphs are shown in Figure 18. The results are characterized by relatively low values at either end of the spec-

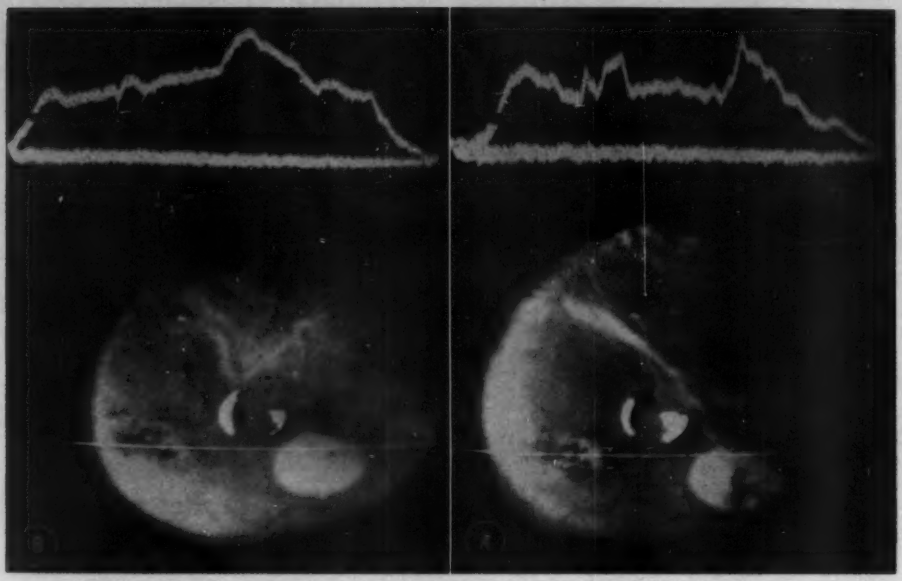
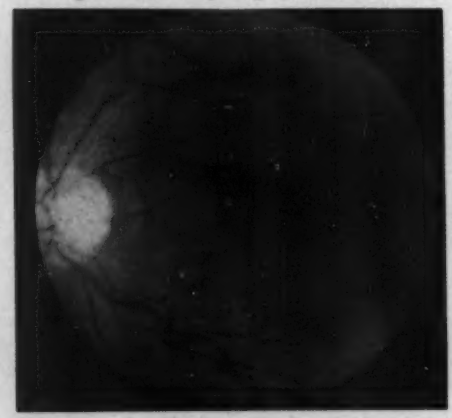


Fig. 16.—Television records of Case 5. Central "exudate." Diminished acuity otherwise unexplained. *A*, 535 mμ; *B*, 680 mμ.

trum and maximum density relative to retina in the green. The approximate parallelism of the curves suggests real uniformity in these findings. The minimum observed in the peak is of more questionable significance.

For the pathological features of Case 3 one may see at a glance that the characteristics of the paramacular lesion do not resemble those of the normal control (Fig. 19). Further, when one compares the bright center with the darker periphery, the curves do not resemble each other. A similar observation may be made in regard to the foveal lesion (Fig. 20). The extreme reflectivity of this lesion at 555 mμ is a remarkable feature and is well shown on the curve. Even in these curves which appear so distinctly different in the short wave length portion, there are some over-all similarities which may be significant as well.

Fig. 17.—Fundus photograph of Case 5.



## Comment

Even in the qualitative use of television ophthalmoscopy there are distinct advantages to be enjoyed. Examination of the integrity of the pigmented macular area may be done at high contrast with the short wave length end of the spectrum. Examination of choroidal vessels and pigment may be done at the opposite end. The instrument is superior to visual observation at these wave lengths because of the lowered sensitivity of the eye at the extremes of the visible region. Television tubes may be obtained which have high sensitivity in the

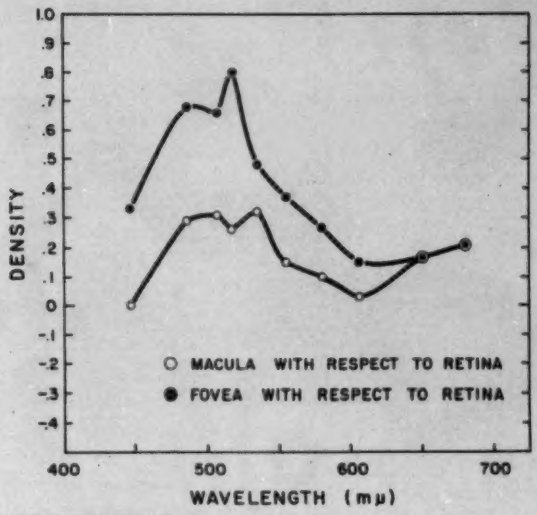



Fig. 18.—Density of macula and fovea versus retina, Case 1 (normal).

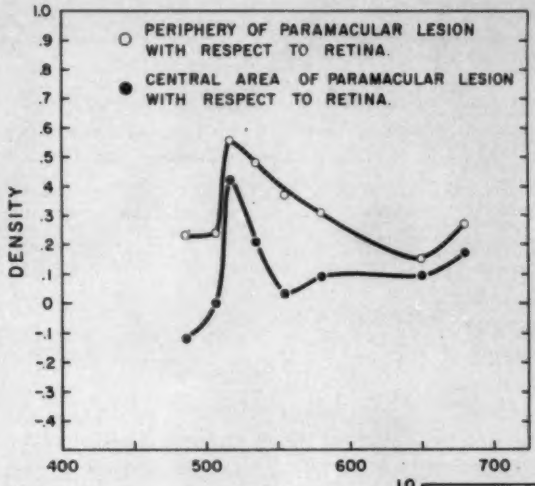



Fig. 19.—Density of paramacular lesion versus retina, Case 3.

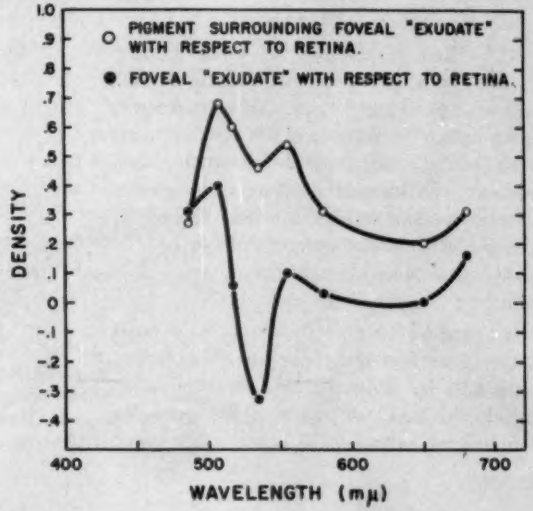



Fig. 20.—Density of foveal lesion versus retina, Case 3.

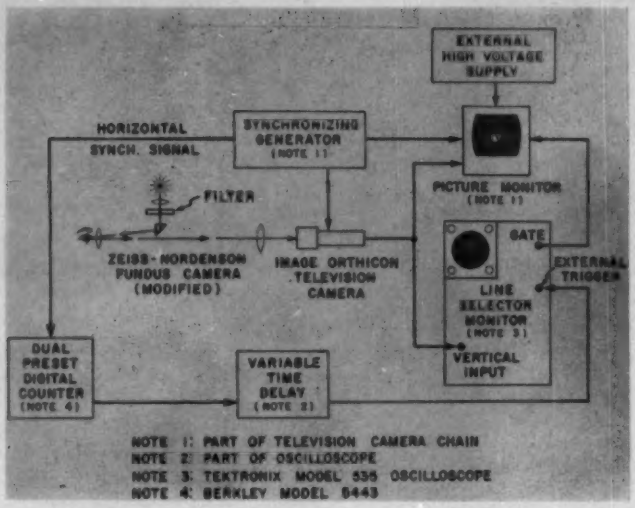

EXTERNAL HIGH VOLTAGE SUPPLY
HORIZONTAL SYNCH. SIGNAL
SYNCHRONIZING GENERATOR (NOTE 1)
FILTER
PICTURE MONITOR (NOTE 1)
GATE
ZEISS-NORDENSON FUNDUS CAMERA (MODIFIED)
IMAGE ORTHICON TELEVISION CAMERA
EXTERNAL TRIGGER
LINE SELECTOR MONITOR (NOTE 3)
VERTICAL INPUT
DUAL PRESET DIGITAL COUNTER (NOTE 4)
VARIABLE TIME DELAY (NOTE 2)
NOTE 1: PART OF TELEVISION CAMERA CHAIN
NOTE 2: PART OF OSCILLOSCOPE
NOTE 3: TEKTRONIX MODEL 535 OSCILLOSCOPE
NOTE 4: BERKLEY MODEL 8443

Fig. 21. — Block diagram of complete television ophthalmoscope.

red and infrared or the extreme violet and near ultraviolet. This allows examination of the monitor in black and white with photopic visual acuity—which is frequently impossible when attempting to view directly at feasible light levels.

Television has the advantage over monochromatic photography in that the result may be seen immediately; slight changes in angulation may be performed to get multiple views; dynamic events may be observed (adequate light levels are not obtainable for direct cinematography of the fundus); the subject is not dismissed before all pertinent information is obtained.

It is much too early to say which features of the quantitative use of the instrument will have permanent value. This will require examination of hundreds of eyes and will ultimately require correlation with many autopsy findings. Even more rigorous standardization and calibration will be required. Absolute measurements would be highly desirable, though these seem most difficult to obtain at present.

It is the purpose of this paper to present simply a method and to outline its potential usefulness by demonstrating its application to selected cases of macular disease. We visualize its extension to many other types of retinal lesions. With the currently mushrooming developments in the technology of electronic image-processing, new tools of great sensitivity, linear response, and high resolution may be soon available to expand our potentialities still farther. Even at its present level, however, we believe that television ophthalmoscopy is a useful new tool in ophthalmic diagnosis.

## Summary

A method of television ophthalmoscopy is described which involves illumination by narrow spectral bands and the use of the line-selection technique.

With this method a number of qualitative observations may be made on normal and pathological eyes.

The method may be used to obtain quantitative information about relative reflection-absorption of any two retinal areas. By comparison of normal with abnormal areas it is hoped that useful new diagnostic information may be obtained.

Applications of the method to the examination of macular disease are presented.

Dr. Vladimir K. Zworykin and Mr. Carl Berkley, of the Rockefeller Institute for Medical Research, put at our disposal the television camera which made this work possible. Mr. Robert Neuhauser, Electron Tube Division, Radio Corporation of

America, Lancaster, Pa., loaned the special developmental type Image Orthicon tube. Miss Edith G. Ray served as control subject at many stages of the research.

2065 Adelbert Rd. (6).

## REFERENCES

1. Ridley, H.: Television in Ophthalmology, Acta XVI Conc. Ophth. 1950, London, pp. 1397-1404, 1951.

2. Vogt, A.: Ophthalmoscopic Investigations on the Macula Lutea in Red-Free Light, Klin. Monatsbl. Augenh. 66:321-363, 718-730, and 838-859, 1921.

3. Kugelberg, I.: The Eyeground in Infra-Red Light, Acta ophth. 12:179-190, 1934.

4. Kornerup, T.: Visual Spectrophotometric Investigations on the Eye with Slit Lamp and Monochromatic Light, von Graefes Arch. Ophth. 159: 323-342, 1957.

5. Zworykin, V. K., and Morton, G. A.: Television, Ed. 2, New York, John Wiley & Sons, Inc., 1954.

## Appendix

*Part I: Theory of Operation, Line Selection.*—Figure 21 shows a block diagram of the complete television ophthalmoscope including the line selector. The fundus of the subject is imaged by the modified Zeiss-Nordenson fundus camera on the Image Orthicon television camera tube.

Monochromatic illumination is obtained by interposing high transmission interference filters having a band width of 50 mμ. The light intensity is modified, if necessary, by neutral density filters in the light path between the condensing lens and the illuminating prism.

The Image Orthicon television camera tube[5] converts the optical image focused upon its face into an electrical pattern. It then scans this pattern with an electron beam of small cross section. The electron beam traces out the scanning raster on the electrical analogue of the optical image. This raster is generated by the scanning cathode ray beam 30 times a second and contains 525 horizontal lines. As the scanning cathode ray beam passes over each element of the electrical pattern it is modified in accordance with the brightness of the optical image at that point. The modified cathode ray beam is collected and appears at the output of the camera tube as the video signal. The video signal is fed to the picture monitor, where it provides a pictorial display, and to the vertical input of the line-selector monitor where it provides the line-selector display.

The synchronizing generator provides the necessary synchronizing signals to the television camera tube, picture monitor, and the dual preset digital counter.

The selection of any given television line proceeds as follows: The horizontal synchronizing pulses produced by the synchronizing generator are fed to the dual preset digital counter, which is set to recycle after it has counted 525 of these pulses. It recycles each time 525 pulses have been counted. During the counting period, the other preset function is set to any desired line number. Thus, during the counting interval the second preset section produces a pulse which coincides with the start of the desired television line. This pulse is fed to the variable time-delay unit. The variable time-delay unit produces another pulse which starts the line-selector monitor (oscilloscope) sweep. Delaying the start of the synchronizing pulse permits the examination of any portion of the horizontal television line with all the horizontal (sweep) magnification of which the line-selector monitor is capable. This feature permits the detailed examination of a very small area of the television picture.

The line selected for examination is marked on the picture monitor by feeding to the picture monitor a signal from the line-selector display, as shown. The result is a bright line on the picture monitor, which marks exactly in both position and extent the portion of the image being displayed on the line-selector monitor.

The picture monitor and the line-selector monitor are photographed for later analysis. For simplicity the photographic setup is not shown in Figure 21. It consists of a standard photographic camera (single lens

reflex is most convenient) with a 45-degree dichroic mirror positioned in front of the camera lens. The dichroic mirror is blue-reflecting and red-transmitting. The line-selector monitor and the television picture monitor are placed at right angles to each other, so that the blue light produced by the blue trace on the line-selector monitor is reflected from the face of the mirror and that red light which is present in the television picture monitor is transmitted through it. Thus, the photographic camera simultaneously records the television picture and the line-selected trace.

The high-voltage power supply, shown in Figure 2, replaces the high-voltage power supply in the control unit of the television camera chain. The latter power supply was found to add radio frequency noise to the video signal.

*Part II: Apparatus.*—1. Zeiss-Nordenson Fundus Camera, modified as follows:

A. The carbon arc of the original camera has been replaced by a 100 watt end-window zirconium arc lamp (Sylvania Electric Products, Inc.).

B. The aspheric objective lens and the original illuminating optics have been retained, but the optical system behind the illuminating prism has been removed. Instead, an f2.5 125 mm. f1 Leitz Hektor lens has been placed approximately 75 mm. behind the illuminating system prism, and this focuses the aerial image on the face of the Image Orthicon tube. A central stop just before this lens blocks most of the central light reflection (from the back surface of the objective lens) which would otherwise wash out the television image. However, small flare spots from the cornea are not eliminated and may be seen on the photographic record.

C. The vertical column in the illuminating system has been modified to permit the insertion of filters. Filters used are 50 mμ band width, high transmission interference filters (Photovolt Corp.) and Wratten neutral density filters.

2. Standard field pickup Image Orthicon camera, RCA Type TK 30A, modified as follows:

A. A special Image Orthicon camera tube which has a greater linear range than is normally the case and high red sensitivity has been added (RCA Developmental Type C 73438).

B. The high-voltage power supply, normally part of the control unit, has been replaced with a special external supply (designed by Western Reserve University Bio-Electronics Laboratory) in order to reduce radio frequency noise in the video signal.

C. The dual preset digital counter (Berkley Model 5443) used for line selection has been added and is synchronized by the horizontal synchronizing signal produced by the camera chain-synchronizing generator.

D. Connection between the line-selector monitor and the picture monitor to indicate the portion of the image selected by the line selector.

3. Cathode Ray Oscilloscope, Tektronix model 525.

4. Recording camera equipment.

A. 35 mm. single lens reflex: Praktika.

B. Dichroic mirror No. 31018 (Liberty Mirror Division, Libby Owens Ford Glass Co.).

*Part III: Case Histories.*—Normal Controls:

CASE 1.—A 35-year-old white woman, brunette fundus.

Patients with Diseases of Fundus Oculi:

CASE 2.—A 60-year-old white woman. Normal eye examination March 26, 1957. Temporal arteritis diagnosed by biopsy one week previously. Sudden loss of vision experienced Aug. 12, 1958, and examination that date demonstrated macular cyst of the right eye. Oct. 23, 1958, repeat examination of fundus with slit lamp indicated that cyst had now perforated, creating hole in the macula with small trap door floating in vitreous above. No retinal detachment. At time of TV ophthalmoscope examination,

March 26, 1959, this condition remained unchanged.

CASE 3.—A 66-year-old white woman. First seen Feb. 26, 1959 with complaint of loss of upper V. F. Examination showed cyst in macula, pigmented scar just below it, and elevated area around knuckle of inferior temporal arteriole c. 1 p. d. below macula. V. O. S. 6/60. March 19, area below macula showed frank hemorrhage. TV ophthalmoscope examination done. May 12, V. O. S. 6/20. V. F. was now more full. Star figure in macula and much pigmentary change in region of inferior lesion. May 13, examination on TV ophthalmoscope repeated.

CASE 4.—A 61-year-old white man. When first seen on June 14, 1958, this patient gave a history of thrombosis of central retinal artery, O. S., 15 years previously; hypertension of 280/150 in the past with treatment by pentolinium (Ansolysen). Coronary thrombosis six years previously. Present B. P. approximately 170/90. Funduscopic examination of the left eye showed areas of vessel-poor retina and several fibrous bands in vitreous. On Dec. 26, 1958, this patient was seen with complaint of sudden onset of "film on the left eye." Examination showed vitreous hemorrhage O. S. On March 3, 1959, vitreous hemorrhage had subsided, leaving a mottled area of central retina with rarefaction of pigment in the center, several pigment deposits, and pigmented peripheral area. Examination on TV ophthalmoscope performed on March 20, 1959.

CASE 5.—A 54-year-old white man. Eye examination on March 13, 1959, not remarkable, except that best corrected V. O. D. is 6/10 (V. O. S.=6/6) and fundus examination shows a white mulberry-like exudate in foveal region O. D. No similar finding O. S. Examination on TV ophthalmoscope performed on March 20, 1959.

# Translucent Behavior of Opaque Cornea

## *Its Possible Application in Corneal Blindness*

ARPAD G. GERARD, M.D., Woodbridge, N. J.

This paper is concerned with corneal blindness and the possibility of restoring image perception in cases of corneal scarring.

Experiments in this field gave me reason to believe that a new approach may be possible in the production of images.

For this study I made a light-proof telescopic sliding tube with a length varying between 10 and 35 cm., with a diameter of 25 mm., both ends covered with black mastic tape, with a 10 mm. round opening at each end.

I had two completely opaque human corneas and two cataractous lenses at my disposal, removed by surgery.

The corneas were kept in a slightly hypertonic alkaline Ringer's solution in which they were well preserved for a few weeks. One side of a clear, thin coverglass was first precoated with sodium silicate binder and then an ultraviolet sensitive zinc sulfide phosphorescent powder was blown on by a hot air blast. When this dried, an even and homogeneous distribution of the phosphorescent material was obtained on the coverglass. Then one cornea was carefully removed from the solution and placed on one clear coverglass, and this was covered by the treated coverglass in such a way that the phosphorescent side was facing the cornea. The cornea was kept moist with a drop of alkaline Ringer's solution and sealed with Canada balsam. The slides containing the opaque cornea were then taped to the objective end of the telescopic tube with the cornea placed exactly in the opening. This procedure was done in order to simulate the inner surface of the cornea being treated with a phosphorescent material. The experiment was done in a lightproof dark room.

The black light of a Hanovia fluorescent lamp (Inspectolite) with two wood filters was directed at three small objects placed on a table. Looking into the telescope, which crudely simulated the eye of a man, total darkness prevailed and nothing could be seen. But when a convex lens of +28 D. made of quartz was placed between the objects and the cornea and the distance of the lens from the cornea was adjusted according to its focal length, a clear fluorescent picture of the objects appeared on the phosphorescence-treated coverglass and was seen distinctly through the telescope.

Impressed with the finding, I made a similar experiment with visible rays. For this purpose, the fluorescent lamp was replaced by an ordinary 100 watt electric bulb and the cornea was placed between two clear, untreated coverglasses. The light of the bulb was directed at the objects and a regular glass lens of +28 D. was put in place and the distance adjusted accordingly. Looking into the telescope a distinct, clear picture of the lighted objects was seen on the opaque cornea. Figure 1 shows the technical arrangement with the exception of the telescope. This was replaced by a camera to photograph the corneal image. Figure 2 shows the photograph. Then the lens was removed from its position between the objects and the scarred cornea. Figure 3 shows the photographed opaque cornea on which no image appears now. There was another cornea available for this study which was more homogeneously opaque. Figure 4 shows the way this cornea appeared without the focusing lens.

Submitted for publication Jan. 21, 1959.

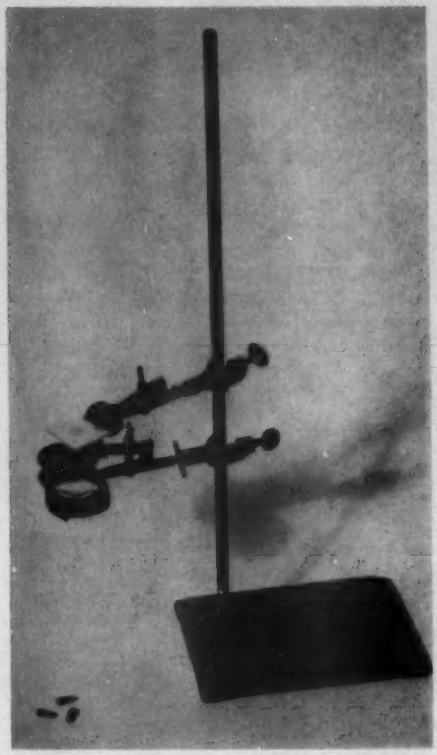


Fig. 1.—Arrangement of objects, focusing lens, and opaque cornea.

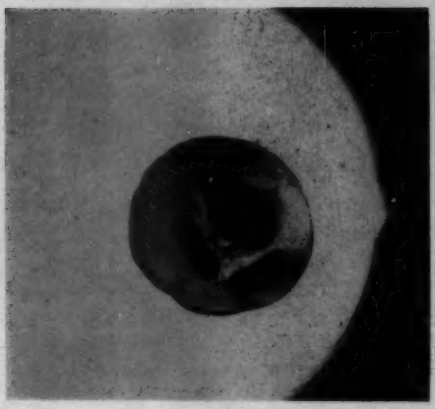


Fig. 2.—Image on cornea produced by focusing lens.

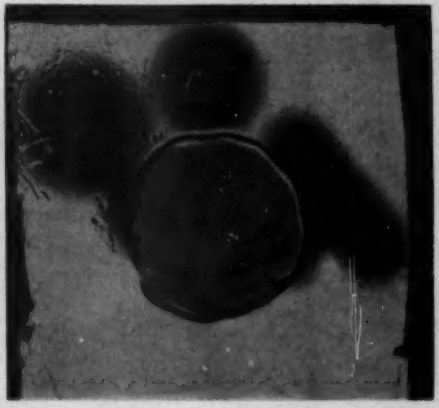
This finding suggests that contrary to the existing concept some opaque corneas are not really opaque but translucent and that they act similar to the ground glass of a camera by diffusing light. (Similar experiments with cataractous lenses did not succeed.)

Could this ground glass effect of the opaque cornea be utilized for projecting the corneal image onto the retina? Could this be used for solving some problems of the blind?

When Ridley [1] described his unorthodox but ingenious operation in removing the cataract lens and replacing it with an acrylic lens, he opened a new field in the operative research of the eyes. Later Strampelli [2] modified Ridley's technique by

Fig. 3.—Focusing lens removed, no image. The scarred appearance of the cornea is obvious.

Fig. 4.—Texture of the other available opaque cornea.



placing an acrylic lens into the anterior chamber. After seven years of experience and observation it can be stated that the lens is well tolerated once the initial signs of irritation and foreign-body reaction subside.

By removing the crystalline lens and replacing it with an acrylic one and at the same time inserting a second acrylic lens into the anterior chamber, the refractive power of the ocular system may be markedly increased. This amounts to a combination of the Ridley and of the Strampelli operations. We do not know whether an eye tolerates such a combination. This was never tried. It should be first performed on animals and then clinically on humans.

Calculations show that projection of a corneal picture onto the retina can not be achieved by a system of two acrylic lenses, the refractory power being inadequate. Therefore, as a final step, lenses made of higher refractive material than acrylic should be developed and used.

The National Lead Company developed two crystalline materials: strontium titanate, with an index of refraction 2.409, and rutile titanium dioxide, with an index of 2.613. Recently, another material has been produced, antimony sulfate [3] with the index somewhat above 3. These new products should be tested for possible use as intraocular lenses.

Should present-day materials prove unsatisfactory, search should be continued until the proper material is found or devised. It seems highly probable that continued search will produce in the future better materials, possibly even with higher refractive index. Methods using these materials may bring light and sight for many otherwise incurably blind persons, no matter how clumsy or primitive the sight will be.

## Summary

Experiments revealed that contrary to the existing concept opaque corneas are not really opaque but translucent and that they act similar to the ground glass of a camera by diffusing light. On opaque cornea images of objects, lighted either by visible rays or by black light, were created. These images were visible and could be photographed.

In utilizing this translucent behavior of opaque cornea to create image formation in patients with blindness due to corneal disease, artificial intraocular lenses of high refractive index might be tried experimentally in animals.

Dr. R. Castroviejo supplied me with the corneas and lenses for this study.

502 Rahway Ave.

## REFERENCES

1. Ridley, H.: Intra-Ocular Acrylic Lenses: A Recent Development in the Surgery of the Cataract, Brit. J. Ophth. 36:113-122 (March) 1952.

2. Strampelli, B.: Supportabilità di lenti acriliche in camera anteriore nella afakia e nei vizi di refrazione, Ann. ottal. 80:75-82 (Feb.) 1954.

3. Personal communication to the author by the Eastman Kodak Company, March 14, 1957.

Clinical Notes, New Instruments and Techniques

# Accessory Instrumentation for the Scleral Buckling Operation

R. DAVID SUDARSKY, M.D., and HERBERT M. KATZIN, M.D., New York

In recent years a large number of procedures have been devised for the treatment of retinal separations. We have been particularly interested in utilizing the scleral buckling procedures of Schepens et al.

In doing scleral surgery a much greater exposure of the posterior segment of the eye is required than was the case for superficial diathermy operations.

In an excellent series of articles,[1-3] Schepens and his co-workers have described primary and secondary buckling operations and the instrumentation and techniques they employ. The instruments presented here were designed as accessories, which, in our hands, greatly facilitate these operations.

Submitted for publication March 3, 1959.

From the Retina Service of Manhattan Eye, Ear and Throat Hospital, supported by The Eye Bank for Sight Restoration, Inc., and by The Avalon Foundation.

Figure 1 shows a pair of *tube forceps* especially adapted to handle polyethylene tubing. The groove which accommodates the tube permits a secure grip on the tubing while one is maneuvering it underneath the mattress sutures without crushing or deforming the tube in any way. Schepens has pointed out[4] that jagged edges or rough portions of the tubing left from previous operations may contribute to accidental perforation of the choroid during reoperations. Also, if the tube is crushed it becomes ex-

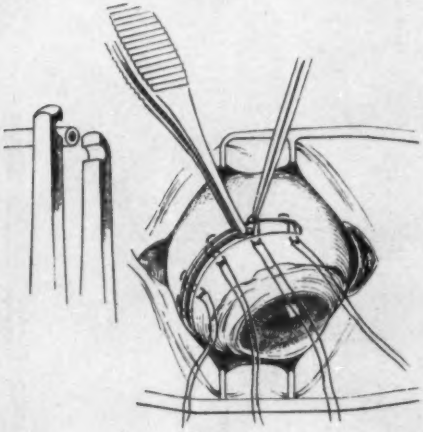


Figure 1

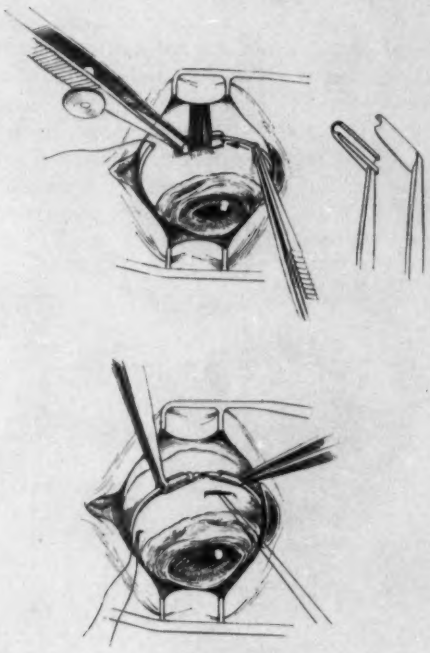


Figure 2

tremely difficult to rethread it with a 00 suture.

The groove is also useful for grasping a single limb of the mattress suture near the bed of the choroid without fraying the suture or perforating the choroid.

Figure 2 shows a *tube clamp* which is designed with a forced opening and closing screw. The clamp is shaped like a muscle hook and can be passed underneath a rectus muscle with ease. It is then opened slightly by turning the screw, and the polyethylene tubing is inserted into the lumen. The clamp is closed tightly on the tubing by the screw, and the tubing can then be easily drawn under the muscle even in the most difficult positions.

The clamp may also be used to secure a tight grasp on the tubing while a second clamp or forceps is used to move the closing sleeve over the knot of the circling suture. This can be done without disturbing the position of sleeves placed elsewhere in the resected area and without damaging or crushing the tube in any way.

The clamp was originally designed with a spring lock which was satisfactory in most circumstances. However, when there is a very tight fit beneath the muscle it was found that a forced opening of the instrument was necessary to enable insertion of the tube, and for this reason the screw was added. We employ two clamps, one with each type of lock.

Figure 3 depicts a *globe repositor*. This instrument is designed to aid in reducing that proptosis of the globe which frequently occurs during the operation, especially when three or more muscles have been detached. Furthermore, it is useful when seeking access to the most posterior portion of the globe, when it is necessary to rotate the cornea entirely beneath the lid. The concave surface of the instrument—approximately 1 cm. in diameter—can be placed with impunity on the cornea or limbus and gentle-to-firm pressure can be exerted against the globe to reposit the globe in the orbit and rotate the anterior segment beneath the lid. The force is spread over such a large area that the cornea does not appear damaged in any way.

A second use of this device is in very soft eyes, especially when placing sutures after subretinal fluid has been lost. The assistant places this instrument at any point on the sclera and exerts a gentle pressure which increases the intraocular pressure to the level required for facile suture placement. In a similar manner it may be used for counter pressure while subretinal fluid is being expressed.

Figure 4 shows a *choroid pick* (*A*) and a pair of *subretinal fluid expressors* (*B*). The former instrument is a simple, ex-

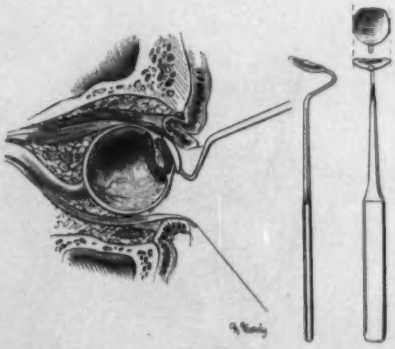


Figure 3

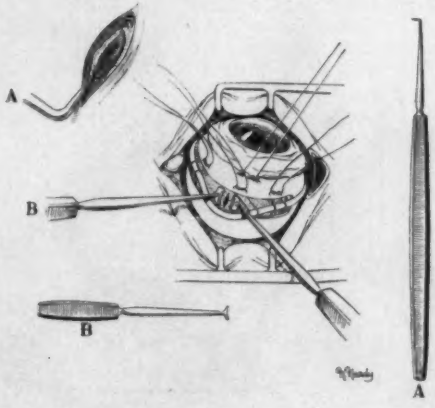



Figure 4

tremely fine stainless steel pick, the sterility of which is maintained until the choroidal hernia has been exposed by dissection. Since this is the only time the operation becomes "intraocular," it is felt that an instrument should be reserved for this important point in the operation.

The *fluid expressors* seem of some value in maintaining the patency of the choroidal hernia during drainage of the fluid. Sometimes it is desirable to insert the globe repositor at an opposite point of the eye to maintain counter pressure and facilitate more complete drainage of the fluid.

The instruments presented here have been used by us for the past 18 months and appear to be definitely helpful in the functions for which they were designed.

210 E. 64th St. (21).

## REFERENCES

1. Schepens, C. L.; Okamura, I. D., and Brockhurst, R. J.: The Scleral Buckling Procedures: I. Surgical Techniques and Management, A. M. A. Arch. Ophth. 58:797-811, 1957.

2. Schepens, C. L.; Okamura, I. D., and Brockhurst, R. J.: The Scleral Buckling Procedures: II. Technical Difficulties of Primary Operations, A. M. A. Arch. Ophth. 60:84-92, 1958.

3. Brockhurst, R. J.; Schepens, C. L., and Okamura, I. D.: The Scleral Buckling Procedures: III: Technical Difficulties of Reoperations, A. M. A. Arch. Ophth. 60:1003-1012, 1958.

4. Schepens, C. L.: Personal communication to the author, 1957.

## Registry of Interesting Cases

*It is the purpose of this section to record cases on the basis of interest only. No complete review of the literature is attempted, and no claim for priority is implied except when specifically stated. Publication of case reports is subject to the concurrence of the Editorial Board on the interesting aspects of the case. It is requested that the reports submitted be as brief as is consistent with inclusion of the pertinent facts, bear a title that is as spesific as possible, be prefaced by a paragraph that states why the author feels the case is of interest, and be accompanied with photographs whenever possible.*

# Hereditary Changes in Skin of the Eyelids

Hereditary changes in the skin of the eyelids are rarely observed. Epiblepharon [1] (folds of skin running horizontally across the lid), blepharochalasis (bagginess of the upper lids due to atrophy and relaxation of the tissues), and a condition simulating senile atrophy may fall into this category. Usher [2] found 21 cases of unusual appearance of the skin of the eyelids in the five-generation pedigree of the kindred of two first cousins with congenital entropion; in 4 of these cases the skin changes were associated with entropion; in 9 other cases there was entropion alone. He concluded that there is a hereditary factor responsible for the skin changes and suggested that the entropion is secondary to skin anomaly.

Fig. 1.—Patient, age 12 years, showing abnormal lower lids.

### Report of Case

The patient, 32 years of age, was examined by me in 1947, when she was 20, and again in 1951 and 1958. She presented no complaints, coming primarily for refraction. There is a bilateral refractive error of simple myopia of low degree. The eyeballs are free of pathology. Her lower lids present a striking appearance. She stated that the lid abnormality had been present

Fig. 2.—Patient, now 32 years of age, showing lower lid pouches and wrinkling of skin.

Fig. 3.—Laxity of the skin.

from earliest infancy and that it has been considered a family trait on her father's side. Two aunts, now dead, had a similar condition. Snapshots taken in infancy and childhood clearly show the abnormality (Fig. 1). At the age of 9 years she was taken to a plastic surgeon because she "looked like a person fifty or sixty years old." Surgery was advised but refused. She has no other congenital anomalies. Her parents have normal lids. She has two sons, one of whom, 8 years of age, has bilateral epiblepharon of lower lids.

Both lower lids show marked pouches (Fig. 2). The skin of the lids is very wrinkled. The eyes open and close normally. The lid margins are in normal position. The lower lacrimal puncta are visible, pointing directly upwards. On palpation the lids are flabby; the skin is thin and inelastic and offers no resistance to downward pull, extending almost to the level of the nostrils (Fig. 3).


## Summary

A case is reported of hereditary changes in the skin of the lower lids, with eversion of the lower lacrimal puncta. The appearance of the skin resembles senile atrophy, and the pouches are analogous to blepharochalasis.



Jesse M. Levitt, M.D.
515 Ocean Ave.
Brooklyn 26.


## REFERENCES


1. Levitt, J. M.: Epiblepharon and Congenital Entropion, Am. J. Ophth. 44:112, 1957.
2. Usher, C. H.: Hereditary Entropion and Hereditary Changes in the Skin of the Eyelids, Biometrika, 24:1, 1932.

Annual Reviews

# The Orbit

*A Review of the Literature for 1958*

FRANK C. WINTER, M.D., Palo Alto, Calif.

## Introduction

It has been a real pleasure for me to be asked to continue the work of Dr. Devoe and Dr. Lemoine in reviewing the literature on the orbit. Like most of us, I have always greatly appreciated the efforts of the reviewers in digesting such great masses of literature and have wondered at their ability to do it. Having done it now myself, I find that it is not half so bad as it might seem, and, while it is still a considerable task, it is a very rewarding one. In the past I have particularly enjoyed the critical comments of the reviewers, and in a few instances where I have felt qualified I have attempted to continue this practice. Since my own particular interests in the orbit are concerned with certain aspects of endocrinology and pathology, attention has been directed especially to these fields.

## Congenital and Developmental Anomalies

Four more cases of anophthalmos have been reported during 1958, and this brings to fifteen the number of cases noted during the past five years in the annual reviews of the orbit. The condition would therefore seem to be somewhat commoner than one would think. Fortunately, most cases continue to be sporadic, inheritance of this trait being an exceptional rarity. Barber [5] presented a preliminary report to the Association for Research in Ophthalmology describing a strain of mice with a genetic background of bilateral anophthalmos. A similar observation was made by Yudkin [157] some years ago in a strain of white rats. Barber found that, when mated to normal mice, the first generation hybrids carry the recessive gene for anophthalmia but have normal eyes. She has also studied the effect of trypan blue, cortisone, and antigens during gestation, and it is to be hoped that more details of this work will appear during the coming year. A number of methods for the experimental production of anophthalmos have been found in the past, including chemical injury (Stockard) [130] and vitamin A (Hale). [52] In most cases anophthalmos apparently comes about through a degeneration of the optic vesicles shortly after their formation in the 3 mm. embryo (3-4 weeks). Thus careful surgical exploration of the orbit or serial sectioning of orbital tissue usually reveals some remnant of ocular tissue. Such a case was recently reported by Vancea. [188] However, complete anophthalmos can result from a failure of development of the forebrain, in which case it is associated with extensive defects of the brain and cranium, or from a simple failure of the optic pit to deepen and form an outgrowth from the forebrain. In mice, Hicks [58] was able to produce anophthalmos by irradiation on the 10th day and anencephaly by irradiation on the 9th day. Anophthalmos is not usually associated with other defects, although Giacomelli [46] reported a case of a child 5 days old with congenital anophthalmos of the right eye and a large cyst of the lower lid. The orbits are usually small, the

Submitted for publication May 4, 1959.

The Department of Ophthalmology, Stanford University School of Medicine.

palpebral fissues are narrowed, and the lids are frequently partially adherent. Pritkin [104] presented the case of a child with apparent bilateral anophthalmos in which no ocular remnant could be made out on surgical exploration of either orbit. He severed the adhesions between the upper and lower lids and reconstructed the margins with a view to later surgical correction so that a prosthesis might be worn.

Girard [47] and associates reported the 15th case of a tumor representing another fetus and containing all three germinal layers occurring as a teratoma of the orbit in a newborn child. Proptosis, chemosis, and enlargement of the orbit were noted at birth. At age 3 months an exploratory craniotomy revealed a cystic tumor the size of an adult thumb attached to the optic nerve at the apex of the orbit. This was removed and microscopically was found to contain a cyst wall lined by squamous epithelium and including elements of cartilage, respiratory and intestinal epithelium, mucous glands, neuronal and glial cells, and a portion of the peripheral nerve. They believed their patient to be unique in that it is the first case in which the eye has been saved. Eighteen months postoperatively examination revealed pallor of the disc and an attenuation of retinal vessels with enlargement of the orbit on that side. The child was otherwise well. Vancea [139] presented the case of a 3-day-old child with exophthalmos and a corneal ulcer. The eye required evisceration and treatment with antibiotics. A mass became palpable in the orbit, and exenteration was done. The mass was cystic and attached to the apex of the orbit by a pedicle. Histologically it consisted of elements of the central nervous system, ocular tissue, skin and its derivatives, cartilage, muscle, and blood vessels. The classic explanation of such tumors is that early in the development of the primordial segmentation spheres a group of totipotent cells becomes separated from the rest with the later aimless development of tissues derived from the ectoderm, mesoderm, and entoderm. While the pathologist may somewhat enjoy looking through the slides for as many different types of tissue as he can find, the clinician can rightfully be thankful that the cases are so rare. Such a happy outcome as that of Girard is unusual, since in most cases there is apt to be explosive growth of a deforming tumor with loss of the eye or death from associated anomalies.

Kleberger [84] reported an unusually large orbital cyst with marked enlargement of the bony orbit in a newborn. This was repeatedly reduced by puncture of the cyst, but by age 3½ years the eye on that side was enlarged and highly myopic and vision was reduced to hand movements at 3 ft. The surgical management of a congenital orbital deformity due to a naso-orbital-craniomeningocele was described by Patterson.[99] The patient was a 2-year-old child who had had partial removal of the lesion previously. There was a large residual defect in the frontal bone with a pulsating exophthalmos and stretching of the upper lid and medial canthal ligament with downward and outward displacement of the eye. Patterson amputated the meningocele at its base and closed the dura with a purse-string suture. The anomalous lateral displacement of the medial wall of the orbit was corrected by trimming and repositioning the bone, which was fixed in place with a wire suture. This reduced the size of the defect in the frontal bone, which was further filled in by a bone graft from the outer table of the frontal bone. The medial canthal ligament was resutured in its correct position. The author showed a picture of the excellent cosmetic result five months postoperatively.

### Tumors

Nover and Zielinski [93] have reviewed their experience with 30 tumors of the orbit and 25 tumors of the optic nerve. They found proptosis a very constant sign in these cases, being present in 29 out of 30 of the orbital tumors and 22 of the 25 optic nerve tumors. Lateral displacement of the globe, when it occured, was exclusively due to orbital tumor, as were retinal folds. There was a tendency for proptosis and disturb-

ances of motility to occur early in orbital tumors, while optic atrophy and papilledema tended to be less severe and later in onset when they did occur. Tumors of the optic nerve were invariably associated with visual loss, and optic atrophy and papilledema were of earlier onset and greater severity. Proptosis tended to come on later. On routine x-ray the optic nerve tumors almost invariably showed enlargement of the optic foramen, whereas tumors of the orbit only exceptionally produced changes in the optic canal. Carotid arteriography was found to be indicated only when there was a question of intracranial extension or if a vascular basis of the lesion was suspected. In the case of orbital tumors, angiography would on occasion demonstrate the presence of pathologic vessels in the area of the tumor, but displacement of the ophthalmic artery was not a helpful sign. Wolter [155] compared the histologic findings in an eye that had shown proptosis and retinal folds due to orbital sarcoma. Beuerman and Tabor [10] reported their experience with the management of seven cases of orbital tumor which represented an incidence of 1 case in 15,581 clinic visits. They advocate adherence to the criteria for surgical intervention outlined by Reese.[105] When the proptosis was accompanied by a well-defined mass appropriate surgery was performed by the most direct approach. When the mass was poorly defined a modified Kronlein approach to the orbit was used. If there was proptosis but no palpable mass a modified Kronlein approach was used if visual function was impaired or retinal striae were present. If there were no pertinent findings other than the proptosis, the policy was to temporize and observe the patient. Lyle [75] agreed with this general policy in a discussion of various causes of exophthalmos, including congenital, inflammatory, vascular, metabolic, traumatic, and neoplastic etiologies. He feels that no orbit should be explored unless a palpable mass is present. However, he performs transconjunctival palpation through a lateral canthotomy if the exophthalmos is progressing, vision is deteriorating, or there is restriction of ocular rotations. Rouher [110] felt that in the case of reticulum-cell sarcoma of the orbit in children the clinical signs are so typical that biopsy is unnecessary, and he advised x-ray treatment only. Offret criticized this position on the grounds that the clinical picture is not necessarily so conclusive. Fregni and DePoli [41] presented an extensive monograph concerned with 255 cases of tumors seen in the EENT clinic of the University of Milan from 1946 to 1957. Forty-three per cent of these presented ocular and/or orbital symptoms. The authors stressed a group of signs which they call "the syndrome of the medial wall of the orbit," consisting of swelling of the internal orbital angle, alterations in the lacrimal apparatus, and impairment of sensibility. They tend to favor local excision of benign tumors and x-ray treatment of radiosensitive malignant tumors. Exenteration is done for recurrent malignancies or radioresistent primary malignancies. Bahn and Hauser [4] reviewed 31 orbital tumors seen in the past five years at the New Orleans EENT Hospital. The series is chiefly remarkable for the relatively high incidence of pseudotumor in their group, 42% in this series as compared to 14% in a larger series (Reese).

A number of cases of leukemic involvement of the orbit have appeared. The fifth and sixth cases of plasmacytoma of the orbit were presented by Pagani [95] and by Lorenzen.[73] The patients were in their sixties, and in one case x-ray therapy is reported to have reduced the exophthalmos. Goodside [50] reported the case of a 76-year-old woman in whom monocular proptosis was the first sign of lymphatic leukemia. The diagnosis was based on the biopsy of a preauricular gland and study of the bone marrow. The peripheral blood showed only a mild anemia. The orbital mass subsided with local x-ray, and the patient died of her systemic disease two years later. Pasmanik [98] presented a case of a tumor of the lacrimal sac which was biopsied and diag-

nosed as leukemia or lymphosarcoma. The patient was treated with 9,000 r in 40 sessions over a period of 62 days. The mass disappeared, and the patient was well after an eight-month follow-up. The author advocated radiation as the treatment of choice and urged its use after primary surgical excision of lymphatic tumors. Mathur [81] reported from India four cases of chloroma occurring in children and giving rise to proptosis. This is an invariably fatal form of acute myelogenous leukemia, in which the greenish tumors represent myelogenous leukemic metastases or infiltrates usually arising subperiosteally.

Spaeth and Valdes-Dapena [127] reported the case of a 36-year-old male who had slowly progressive ptosis and proptosis of the right eye with removal of an orbital tumor in 1951. This proved to be a hemangiopericytoma which recurred in 1953 and required exenteration and treatment with 4,000 r of x-ray. A further recurrence required removal of all bony tissue of the orbit and the placement of 16 radon seeds. The tumor recurred again, and these nodules were removed and 10 radium capsules were placed, giving an estimated dose of 5,000 mg. hours. At present, there is further recurrence and the left eye is immobile with exophthalmos due to intracranial extension through the middle fossa. The morphology and significance of the pericytoma cells was discussed, and its radioresistence was noted. The tumors consist of endothelial-lined vascular spaces surrounded by masses of usually small and poorly arranged cells derived from pericytes. Histologically, the tumor resembles a hemangioendothelioma, from which it can be differentiated by special stains that reveal its tendency to perivascular rather than intraluminal growth. The tumors are usually slow-growing and benign, although about ⅓ of reported cases have been locally invasive and capable of metastasis. Without saying so, Spaeth left the impression that he might perform exenteration in the next case as a primary procedure.

Sommerville-Large and O'Meara [126] had an unusual case that they determined to be a malignant synovioma of the superior oblique muscle. This is a connective-tissue tumor arising from synovial sheaths of joints, bursi, and tendons or from fascial aponeuroses.

The tumor may take a benign but highly cellular form, in which mesothelial-lined clefts appear, simulating the synovial cavity, or a malignant form may occur, characterized by mucinous and fibrosarcomatous degeneration. Often individual tumors show various degrees of both histologic forms. This was the first presentation of a synovioma of the orbit. The patient was a 3-year-old boy seen because of ptosis of the left upper lid. There was no exophthalmos or limitation of movement of the eye. A firm, pea-sized nodule was palpable in the region of the trochlea. Surgical exploration revealed an extension into the orbit, but nothing further was done at this first operation. The mass grew rapidly to the size of a walnut and was removed 11 days later. The histologic picture of malignant synovioma was seen, and exenteration was done, followed by 5,000 r to the socket. There has been no recurrence in five years.

Pulsating exophthalmos in von Recklinghausen's disease was discussed by Langmaid and Daws,[68] who pointed out that exophthalmos in this condition may be due to (1) orbital tumor, (2) glioma of the optic nerve, or (3) defect in the orbital bone. The bony defect may involve the posterior portion of the orbital roof, in which case the pulsation is transmitted from the intracranial cavity; there may also be progressive exophthalmos if the condition is associated with an intracranial tumor. Well-defined x-ray defects of the orbit are relatively common in this disease. Characteristically, there is loss of bony detail in the posterior part of the orbit due to partial absence of the orbital plate of the frontal bone and/or lack of development of the greater and lesser wings of the sphenoid. The affected orbit is usually larger than normal. Preliminary angiography and

air studies should precede repair of the bony defect to rule out possible associated intracranial tumor. If this is present, spontaneous decompression through the orbital dehiscence may be desirable if intracranial pressure is rising. Girard, Bonamour, and Robert [48] also presented two cases of this entity.

Carey [20] reviewed 5 epidermoid and 2 dermoid tumors seen in a series of 293 orbital and orbitocranial tumors on the neurosurgical service of the National Hospital, Queen's Square, London. The author defined epidermoid tumors as those whose walls are composed of squamous epithelium only, and he considered that they arise from embryonic inclusions of epithelial cells. A synonym for this type of tumor is "pearl cyst," while the name cholesteatoma is sometimes used for both epidermoid and dermoid tumors. Dermoids are defined as cysts lined by squamous epithelium and dermal elements, including connective tissue, hair follicles, and sweat and sebaceous glands. These tumors arise through the embryonic inclusion of both the epithelium and its associated dermal tissue. Both types of tumors produce a slowly progressive proptosis and swelling of the lids with impaired ocular motility and sometimes reduced visual acuity, field defects, and pallor of the optic nerve. Characteristically, x-ray reveals a well-defined, translucent defect of the orbital bone with a surrounding zone of increased bony density. In this series anterior, frontal, or transcranial surgical approaches were used. The author preferred a frontal craniotomy combined with removal of the lateral wall of the orbit as the approach giving the best exposure and best suited for the management of intracranial extension, which was present in four of the seven cases. Pajor [98] published the case of a 41-year-old man who developed ptosis and proptosis of the right eye. X-Rays revealed a defect in the bone of the roof of the orbit and a large cyst or mass in this area. Upon removal via a transfrontal approach the mass proved to be a cholesteatoma. This case serves to illustrate the point that, while these lesions originate in a congenital fault, the tumor itself may develop very slowly and not give rise to appreciable symptoms until late in life. Lindner [72] advocated the coagulation of dermoid cysts of the orbit with 30% trichloroacetic acid, as being the simplest method of treatment of these lesions. The possible unpleasant affects of this, should the material escape into the orbit or should there be an intracranial extension, would make one hesitate who had not seen the method used. It would seem that where possible surgical extirpation should continue to be the operation of choice, although in some cases of diffusely infiltrative dermoid where complete excision is impossible, chemical coagulation of the remnant of the capsule is useful.

Two case reports concerned with meningioma have appeared. The case of Thiébaut [131] was a 33-year-old man who developed epilepsy and proptosis of the left eye. He was treated by excision of the tumor through a transfrontal approach with recovery and regression of the exophthalmos. Crudeli [29] reported a 31-year-old patient whose first symptom was failing vision in one eye due to a small central scotoma. There was slight temporal pallor of the disc. Vision continued to fail, and proptosis developed. At this time x-ray showed enlargement of the optic foramen. At craniotomy a mass was removed from the right optic canal, but vision failed to improve. Toppozada [134] reported a ganglioneuroma in a 4-year-old girl, arising from the region of the left maxilla and invading the orbit with displacement of the eye and diplopia. The tumor was removed and did not recur in a period of five years. Ugelli and Pollizzi [135] reported two patients with hydatid cyst of the orbit. The authors stated that diagnosis of hydatid cyst is always difficult and exploration of the orbit is usually necessary. In their two cases, a Kronlein approach was used and the cysts removed without incident. A case of multiple lipoma of the orbit is reported by Valu [137] and a case of

eosinophilic granuloma of the orbit by Volpi and Bertoncini.[147] Chatterjee[22] reviewed the literature on osteoma and reported a case with surgical removal. He quoted several authors as stating that this tumor can be approached subperiosteally from a brow incision, but in his case the periosteum was adherent to the tumor and incision through the orbital septum with excision from within the orbit was necessary.

A most interesting and instructive paper was presented by George Merriam,[87] concerned with the radiation dose to the lens in treatment of tumors of the eye and adjacent structures. In a previous paper this author had studied the roentgen doses involved in 100 cases with cataract and 73 cases without and found that there was approximately a 50% chance of cataract with a lens dose of 700 r. The recent paper reported the results of direct measurement of lens dose as measured on a cadaver phantom when the doses and techniques currently employed at the radiotherapy department of the Memorial Center, New York, were simulated. The conditions set up were those used in treatment of carcinoma of the antrum, carcinoma of the nasopharynx, cerebral metastases, radiation of the pituitary gland, lymphosarcoma of the orbit and of the lacrimal gland, carcinoma of the hard palate, carcinoma of the orbit and of the lids, retinoblastoma, and metastatic carcinoma of the choroid or orbit. In most instances lens doses in the range 150-400 r were found. In some severe cases, however, such as nasopharyngeal carcinoma extending to the ethmoids, lens doses of 1,000 to 1,500 r may have to be accepted. Lederman discussed the techniques of direct and indirect shielding of the eye used at Royal Marsden Hospital, London. The doses used and the dose distributions with and without shielding were shown.

### Diagnostic Technique

An extensive and beautifully illustrated monograph in German has been presented by Yasargil[186] on the roentgen diagnosis of orbital lesions. The paper is based on a study of 114 cases of unilateral exophthalmos with use of techniques of standard orbital x-ray, the injection of radio-opaque contrast media and air into the orbital tissues, and angiography of the carotid artery and angular vein. The illustrations are excellent and show that the ophthalmic artery and orbital veins can be made out very clearly by these techniques, together with such pathologic processes as varicose dilatations, aneurysms, and the vascular patterns of certain tumors. The author felt that conventional x-rays are adequate if the lesion produces bony changes but that contrast media are essential where the bone is not involved. He found air injections of orbital tissues especially useful in cystic tumors. He warned against the use of iodine-containing contrast substances for local tissue injection. For angiography he found best results from the use of a diatrizoate preparation (Urografin, Schering) for carotid artery and angular vein injection. In a separate paper Krayenbühl[65] presented a detailed report on 9 of the 117 cases making up the basis of Yasargil's monograph. These nine were cases of unilateral exophthalmos in which the cause was detected by orbital angiography. Injections of Urografin were made into the carotid artery and into the angular vein. Because of their irregular course, displacement of the ophthalmic artery and other orbital vessels by a tumor is difficult to demonstrate. However, in one case of glioma of the optic nerve a medial displacement of the ophthalmic artery could be seen. In six of the cases the tumor was made out because of filling of tumor vessels which outlined the mass. Phlebograms of the orbital veins revealed tremendous dilatation of the angular and superior ophthalmic veins in one case of carotid-cavernous aneurysm and an orbital varix in one other patient with minimal proptosis. In reading this paper it is apparent that, while angiography was interesting and informative, adequate basis for the clinical diagnosis and managements of the patients was available from the history and symptomatology with-

out resort to orbital angiography. In each case the diagnosis of space-occupying orbital mass was obvious, and a more specific diagnosis required surgical exploration of the orbit and histologic examination. It was in the two cases with a vascular basis that angiography was best able to indicate the nature and extent of the lesions. It would therefore seem that angiography of the carotid artery and angular vein would have its principal usefulness in orbital lesions of a vascular nature, in which case it should be possible to indicate the type and extent of the lesions, especially as regards possible intracranial extension that might have a critical bearing on the clinical management of the case.

Somewhat similar experience with angiography and ptomographic orbital x-rays were reported by Vannini and Pettinati in two papers.[141,142]

Bertelsen and Petersen[9] outlined their technique for orbital pneumography. They placed air behind the globe beneath Tenon's capsule and examined the orbit by ptomography in two planes at intervals of 0.5 cm. Eight patients were examined by this technique in which routine x-rays had failed to reveal the cause of exophthalmos. In two of these a mass could be demonstrated by air contrast and ptomography. An article on orbital pneumatocele following trauma was presented by Fourcade,[38] in which he discussed two cases of crepitation and emphysema following frontal fracture with x-ray demonstration of air in the orbit.

In a very detailed and beautifully illustrated article in German, Wiegand[154] presented his method of x-ray demonstration of the optic canals for stereoscopic viewing.

Two articles have appeared in which the authors critically assessed the value of orbitonometry in the differential diagnosis of orbital tumors. Ferrer Arata[37] and his associates reported from Buenos Aires their experience with 11 patients with orbital tumors. The cases were studied to see if orbitonometry could furnish information on the site, size, consistency, and fluid content of orbital tumors. They concluded that some information on compressibility and resiliency could be obtained, but the site, size, and nature of the lesion was not elucidated by this method. Dyer and Henderson[35] studied the clinical diagnostic value of orbitonometry in 36 cases of unilateral exophthalmos including various tumors and inflammatory diseases and Graves' disease. They found that posteriorly placed tumors and diffuse edema or infiltration produced the greatest resistance to retrodisplacement of the eye, while anterior tumors and mild edema caused least resistance. However, they did not find orbitonometry helpful in the differential diagnosis of unilateral lesions, and normal orbital compressibility did not rule out the possibility of a space-occupying lesion of the orbit. They felt a good history together with the clinical signs and symptoms and the results of other routine studies to be the most reliable index in the diagnosis of exophthalmos.

Barthelmess[6] advocated careful observation of the limitation of ocular rotation with a Hess screen as a diagnostic and prognostic aid in expanding orbital lesions. He called the method coordimetry, which is presumed to mean the measurement of ocular coordination. I have used a somewhat more direct method of measurement of limitation of ocular rotation on the perimeter and have found it to be of considerable help in certain affections of the orbit, especially in the evaluation of the results of steroid therapy in progressive endocrine exophthalmos.

### Progressive Endocrine Exophthalmos

Much of the investigative work in the diseases of the orbit during 1958 was concentrated in the field of endocrine exophthalmos. In reviewing this literature it soon becomes evident that we are still laboring under a plethora of terminologies for the same thing. Not only are such synonyms as thyrotropic exophthalmos, exophthalmic ophthalmoplegia, malignant exophthalmos, and hyperophthalmopathic syndrome in common use, but some authors continue to title

their papers on this subject "exophthalmos of Graves' disease" or "exophthalmos of thyroid disease." This not only raises the possibility of confusion with the relatively simple and benign exophthalmos of thyrotoxicosis but also completely ignores the fact that progressive endocrine exophthalmos is only indirectly related to thyroid function and is much more intimately related to pituitary function. For the sake of all those who review the ophthalmic literature, to say nothing of ophthalmology in general, let us all unite behind the simple and noncommital terminology proposed by Cordes,[28] in 1954: "progressive endocrine exophthalmos." A number of authors are already using this terminology, and I heartily commend them all.

Much of this confusion, of course, arises from the fact that our present concept of the endocrine physiology of this disease still is very incomplete. The indirect relationship to thyroid function per se is indicated by the fact that progressive endocrine exophthalmos, especially the milder cases, usually arises spontaneously. When it does the patient may be hyperthyroid or hypothyroid but is usually euthyroid. Similarly, when progressive endocrine exophthalmos does follow thyroidectomy, the patient may show evidence of thyrotoxicosis or of myxedema but usually has normal thyroid function. Recent work by Friis and Chapman[42,43] indicated that thyroid function in some of these euthyroid patients may nevertheless be abnormal in some respects. They compared the rate at which a test dose of radioactive iodine was converted to protein-bound radioactive iodine and found that this rate was increased in eight patients with malignant exophthalmos. They inferred that, while the hormone level was apparently normal in metabolic activity, it was being hastily produced and there was little or no storage of the radioactive iodine.

Further work on the pathogenesis of experimental exophthalmos has been carried out by Smelser and Ozanics.[119-122] The present status of their work may be summarized as follows: The most notable feature of the orbital changes in experimentally produced exophthalmos is the swelling of the connective tissue, including that of the orbital fat, the septa of the glands and the perimysium of the muscles. The connective tissue fibers are separated by a fluid which in hematoxylin-and-eosin-stained sections is seen as a homogeneous acidophilic ground substance found throughout the orbital contents. The infiltrate contains only a few cells, some of which are lymphocytes, macrophages, and polymorphonuclear leukocytes. An as yet unproven hypothesis to explain the accumulation of this fluid suggests that the connective-tissue cells under abnormal conditions form an unusually large amount of hydrophilic mucopolysaccharides in the ground substance. It suggests that these connective-tissue mucopolysaccharides (hyaluronic acid and chondroitin sulfate) attract and bind water. This hypothesis implies that the orbital connective tissue of exophthalmic animals is more hydrophilic than that of normal animals. In a careful experimental study Smelser and Ozanics[119] showed that the orbital connective tissue of exophthalmic animals was significantly more hydrophilic than that of thyroidectomized and normal guinea pigs. Not only was the orbital tissue of exophthalmic guinea pigs found to take up more water than control animals, but orbital tissues from the most extreme cases of exophthalmos were demonstrably more hydrophilic than those from cases with moderate exophthalmos. They concluded that at least part of the swelling of the orbital connective tissue in exophthalmos is due to a change in its ability to attract and hold water. In previous work Smelser and Ozanics had found that cortisone potentiated the exophthalmos produced in experimental animals by injection of pituitary extract, and this raised the possibility that this form of exophthalmos might be dependent on the presence of adrenal steroids. Accordingly, these authors[122] studied the results of anterior pituitary extract injections in adrenalectomized, oophorectomized thyroidec-

tomized guinea pigs. The authors concluded that exophthalmos following anterior pituitary injection in guinea pigs does not depend on the presence of adrenal steroid for its production.

In an excellent review of this general subject Asboe-Hansen,[2] of the Connective Tissue Laboratory, Copenhagen, restated some of the more recent findings of his own and other workers bearing on the problem of exophthalmos and pituitary-thyroid relationships. Asboe-Hansen believes that the thyrotropic hormone exerts a direct effect upon connective tissue separate from its thyroid-stimulating function. This effect is seen in thyroidectomized guinea pigs and consists of a mucinous replacement of orbital fat resulting in water-binding and exophthalmos. This fat-mobilizing and mucotropic effect is found also in the perirenal, axillary, and peritesticular tissues. Thyroid hormone, thyroxine, and triiodothyronine inhibit this effect. Thyroid-stimulating hormone increases the size of the cytoplasmic granules of the mast cells, while corticosteroids produce the opposite effect. In human malignant exophthalmos, acromegaly, thyrotoxicosis, and myxedema (conditions in which thyroid-stimulating hormone plays a role), accumulations of mucopolysaccharide have been demonstrated beneath the sarcolemma of various muscles, including the quadriceps, the biceps, and retrobulbar muscles. In these conditions Asboe-Hansen also found a local accumulation of mast cells and suspected that this is related to the increased connective-tissue mucoid. While work such as this is of great theoretical interest and provides stimulus for speculation and investigation, it is proper that the clinician be reserved, not only because the findings lack direct applicability but also because many of the techniques are still necessarily crude and the interpretations somewhat empirical. This must necessarily give rise to conflicting results, as witness the present paradoxes that surround the role of steroid hormones in connective-tissue metabolism.

A recent study by Larsen [60] would seem to support some of the ideas of Asboe-Hansen. Larsen studied the changes in the viscosity of the vitreous of rabbits after treatment with cortisone, thyroidectomy, and combined thyroidectomy and TSH administration. While thyroxin, thyroidectomy alone, and cortisone had little or no effect, the combination of thyroidectomy and TSH caused a considerable increase in the viscosity of the vitreous. This would agree with the concept of TSH as a mucotropic agent and thyroid hormone as a mucolytic factor.

Unfortunately, the exophthalmos of the experimental animals is not strictly comparable to the human disease, primarily because the inflammation and vascular congestion that are so prominent in the human cases are entirely absent in the experimental animals. The transfer of information from the experimental animals to clinical cases in humans is further complicated by the fact that there is still no direct method of assay for the exophthalmos-producing substance (EPS). Dobyns [34] reported some years ago that the sera of patients with progressive exophthalmos contained a substance capable of producing exophthalmos when injected into an Atlantic minnow (Fundulus heteroclitus). Unfortunately, this bioassay technique is difficult to manage and gives conflicting results in the hands of various investigators. Pollack [103] and associates reported that exophthalmos was consistently produced in the Atlantic minnow after injections of crude anterior pituitary extract or commercial TSH. However, fish receiving injections of sera from several patients with progressive exophthalmos did not become exophthalmic. The authors felt that there was some evidence of a substance in the sera of the patients that inhibited the exophthalmos-producing factor. They also were unable to produce exophthalmos with thyroxin or triiodothyronine. The opposite was reported earlier by Langford,[67] who produced exophthalmos in Fundulus with triiodothyronine or dessicated thyroid but not with a pituitary preparation. Matty, Menzel, and Bardach [82] reported the production of convincing exophthalmos in two species of teleost fish after the injection of

methyltestosterone or testosterone phenyl acetate. They were also able to produce exophthalmos with thyroxin and triiodothyronine. This paper raises the possibility, of course, that the exophthalmos-producing substance found by Dobyns in the sera of patients with progressive exophthalmos might have been an androgen or thyroid hormone and not a pituitary hormone at all.

In contrast to the difficulty in assay methods of the exophthalmos-producing substance, considerable progress is being made in the bioassay of thyroid-stimulating hormone (TSH). McKenzie [85] published his findings with the Adams-Purves technique, wherein mice are given injections of radioactive iodine and then have their endogenous thyrotropic hormone production suppressed with thyroxin. The effect of a test dose of TSH or of an unknown sera is measured then by the per cent release of $I^{131}$ into the sera. With use of this method the author found a linear relationship to the log of the dose and found it possible to detect as little as 0.025 milliunits of TSH with an injection volume of 0.5 ml. The range of error was about 25%. Test doses of saline, growth hormone, various serum and plasma extracts, and injections of epinephrine and hydrocortisone failed to give false positives. With this technique the author estimated a normal serum TSH level is about 0.2 milliunits per milliliter. He also mentioned electrophoretic studies in which the TSH traveled with the γ-globulin fraction of human serum. Adams [1] tested the TSH activity of pituitary extracts and sera from a variety of animals and human subjects by measuring the release of radioactive iodine from the thyroid of guinea pigs. He found that the sera from some cases of thyrotoxicosis elicited abnormal TSH response, in that the rate of release of radioactive iodine was several hours slower and the magnitude not so great after injection of the test sera as after the injection of standard U. S. P. Thyrotropin Reference Substance.

In two papers Bottari [14,15] and associates report what appears to be perhaps an even more precise method of bioassay for thyrotropin in which guinea pig thyroid gland slices are incubated with radioactive iodine and the amount of $I^{131}$ picked up is determined. The gland tissue is then further incubated with thyrotropin or with unknown sera and the amount of $I^{131}$ released into the medium is found to be quantitatively related to the amount of thyrotropin present. By this method the blood of normal rabbits contains approximately 15 milliunits of thyrotropin per 100 ml., and the author found the limit of sensitivity to be approximately 0.001 milliunits of International Standard. When applied to humans the author reported a normal TSH level of 22 milliunits per 100 ml. of serum for male adults. The range was 10-45 milliunits. For women before menopause the level was 37 milliunits, and after the menopause this fell to 20-25 milliunits. With increasing age the value fell to a mean of 5 milliunits per 100 ml. for both sexes. Thyrotropin was found to disappear from the serum after hypophysectomy, while in myxedema the TSH level was increased to from 200-800 milliunits per 100 ml. With thyroid-replacement therapy this value returned toward normal. Thyrotoxicosis was usually found to be associated with increased TSH, but in some cases TSH was normal, and in at least one case it was definitely decreased in spite of intensive treatment with propylthiouracil. In summary this assay method appears to be very precise and reproducible, and the values of the thyrotropic hormone found in the various conditions tend to support our present concepts of the relationship between the pituitary and thyroid glands. With these techniques it should be possible to determine more exactly the role of thyrotropic hormone in progressive endocrine exophthalmos.

Several papers have appeared concerned with pituitary-thyroid relationship. Deiss [31] and associates have shown that TSH given 24 hours after radioactive iodine caused a prompt release of protein-bound radioactive iodine within 30 minutes. It was not until 12-30 hours after the TSH had been given,

however, that a stimulus to plasma radioactive iodine uptake was noted. This indicates that thyrotropin first causes a release of stored hormone and that this is then followed by an uptake of iodine from the serum by the thyroid gland, presumably for the synthesis of new hormone. In a paper that may offer some guidance to the clinician who is giving thyroid hormone or its analogues to patients with progressive endocrine exophthalmos, Bierwaltes [11] has studied the effects of excessive dosage of thyroxin and triiodothyronine in euthyroid humans. He confirmed the previous reports by Selenkow and Asper [8] on the relative "strengths" of some of these drugs, that is, 3 gr. of dessicated thyroid (1.9 mg.) equals 0.3 mg. of thyroxin, and this is approximately equivalent to 0.1 mg. of triiodothyronine. Maximum doses of five to six times these amounts were studied. As might be expected, the basal metabolism rose and the cholesterol values fell. On withdrawal of thyroxin, the basal metabolism continued to rise and the cholesterol to fall for a few days. This was not seen after withdrawal of triiodothyronine. Wolff [148] has noted an interesting inhibitory effect of salicylates upon the thyroid gland in man and rats. He feels that this inhibition of thyroid gland function is due to a reduction in thyrotropic stimulation brought about at a pituitary or higher level. There is a possible therapeutic implication here for the ophthalmologist for, while medical attempts at pituitary suppression have so far not been productive, a trial of salicylates should do no harm and might possibly be of benefit in the clinical management of progressive endocrine exophthalmos. The tendency of emotional stress to precipitate progressive exophthalmos is well known and pituitary hypothalamic relationships have been demonstrated in man and animals. Various neurological pathways and connections between the pituitary and the hypothalmus were discussed by Merz,[88] who believes that each disease has its psychic and somatic component.

A number of case reports, clinical observations, and reviews have appeared that deal with this subject.[18,23,24,44,77,108] Hamilton [53] and associates studied the records of 165 patients with thyrotoxicosis, unselected so far as eye complications are concerned but treated with radioactive iodine and studied from one to six years. Of these, 77% exhibited periocular symptoms and signs, which were severe in 11%. Exophthalmos remained the same or increased in 89% while under treatment. In most instances soft-tissue reaction subsided with control of thyrotoxicosis. The paper is spoiled somewhat by the failure of the authors to differentiate clearly between the eye signs of progressive endocrine exophthalmos and those of pure thyrotoxicosis. It is not clear, therefore, exactly how many of these patients actually developed progressive exophthalmos. McHugh and Mellinger [84] reported an interesting case of a 62-year-old woman who 12 years after subtotal thyroidectomy developed mild progressive exophthalmos associated with edema and congestion of the lids and conjunctiva and a limitation of ocular rotations and pretibial edema. The patient was euthyroid, and initial radioactive iodine uptake of 36% was reduced to 10% after administration of thyroxin. The exophthalmos and edema were not improved by this therapy in a period of four months' observation. In their discussion the authors cited the work of Werner,[153] who has shown that, while normal persons have a reduced radioactive iodine uptake after thyroxin administration, patients with Graves' disease do not show reduced radioactive iodine uptake after thyroxin administration. They concluded that in their patient there was a normal pituitary thyroid relationship and that the exophthalmos-producing substance is not thyrotropin and is independent of both thyrotropin and thyroid hormone levels. Others, including myself, have found that spontaneous cases of endocrine exophthalmos occurring in euthyroid persons react as do those in normal subjects to thyroxin

administration with a reduction in radioactive iodine uptake values. While there is now wide agreement that the exophthalmos-producing substance is not identical with thyrotropin, it remains to be seen whether or not it is entirely independent of both thyrotropin and thyroid hormone levels. In this regard it is interesting to note the case, reported by Morgan and Mason,[90] of a 39-year-old white woman who had exophthalmos with sore, red, and watering eyes for 18 months, followed by hypertension and the typical hair and fat distribution of Cushing's disease. There was no ophthalmoplegia at any time. The patient was psychotic and committed suicide, and at autopsy hyalin changes in pituitary basophils were reported, together with slight hyperplasia of the adrenal cortex. The thyroid gland was histologically normal. This case recalls the report of Plotz, Knowlton, and Ragan,[102] who found some degree of exophthalmos in 8% of 189 cases of Cushing's disease.

In two papers Weekers and Lavergne [151, 152] presented their interesting new finding of decreased ocular rigidity in endocrine exophthalmos. In 293 normal persons they found average ocular rigidity to be 0.0246, with extreme variations from 0.0100 to 0.0400. In 26 cases of hyperthyroidism the average ocular rigidity compared closely with this normal value, that is, 0.0226, with extremes from 0.0170 to 0.0325. In six patients with progressive endocrine exophthalmos ocular rigidity was markedly reduced to an average of 0.0115, with extremes of 0.0080 to 0.0150. In four of these patients endocrine exophthalmos was associated with hyperthyroidism, while in two other cases of progressive endocrine exophthalmos the patients were euthyroid. Decreased ocular rigidity appears to be associated with chemosis of the conjunctiva rather than with ophthalmoplegia, since they found "normal ocular rigidity in three cases of bilateral ophthalmoplegia of endocrine origin which showed similarities to thyrotropic exophthalmos but lacked conjunctival edema." The authors also pointed out the importance of making a correction for ocular rigidity when testing the ocular tension of these patients. When such a correction was made, three of their six patients showed ocular tensions in the low glaucoma range. They found glaucoma in these patients to be rather resistant to treatment with miotics but responsive to acetazolamide (Diamox) or 2% epinephrine. They also found this form of glaucoma capable of producing field changes. The implication of these findings is that the same factor or factors that produce the changes in the connective tissue of the orbit also alter the ground substance of the sclera in such a way as to reduce ocular rigidity.

Little is known about the glaucoma sometimes associated with endocrine exophthalmos, but Henderson [56] mentioned some of his findings seen at the University Hospital, Ann Arbor, Mich. He pointed out that there are a number of factors which tend to give erroneously high readings in these patients. Among these he listed the pressure of the lids upon the globe, the pressure of the examiners' thumb in helping to hold the lids apart, and the tendency of the weakness of the levator muscles to cause a greater than normal effort on the part of the patient in looking upwards during the taking of the tension. He reported one patient who showed a difference of almost 30 mm. of mercury on the tonometer scale between the high pressure recorded when he was looking upward against his weakened superior rectus muscles and the normal pressure recorded when he was looking downward in a position of relaxation. In those patients thought to have true glaucoma he found routine miotics sufficient to control elevated tension. He also mentioned a group of patients in which it is very difficult to determine whether the reduction in vision together with changes of the visual fields and elevated pressure are the result of true glaucoma or of pressure effects upon the optic nerve at the apex of the orbit during an acute congestive phase.

The question of visual field changes in patients with progressive endocrine exoph-

thalmos has been reviewed by Henderson,[57] who combines 6 cases from the Mayo Clinic with 10 cases previously reported by Igersheimer[61] and by Hedges and Scheie.[55] The majority of these patients showed central scotoma, but paracentral scotoma and nerve fiber bundle defects or a combination of these two also occurred. The periphery of the visual fields generally remained unaffected. The occurrence of field defects does not correlate with the severity of the exophthalmos or orbital disturbances. As many cases occurred in association with mild as with severe orbital signs. In most instances the fundi were normal, although one patient had an associated pallor of one optic disc and one other patient had an associated papilledema. The degree of visual recovery varied considerably with the tendency being towards recovery of function. In no instance was a patient left helpless by loss of vision. A careful effort was made to correlate the response of the disease to various forms of treatment, including propylthiouracil, radioactive iodine, dessicated thyroid, iodine solution, corticotropin, x-ray radiation to the orbits, subtotal thyroidectomy, and decompression of the orbits. The author found it impossible to relate definitely either the onset of the visual failure or its improvement to the influence of any particular treatment. The course of the disease, in other words, seemed independent of the treatments attempted. Henderson distinguished sharply between the papilledema sometimes seen in progressive endocrine exophthalmos and the optic neuropathy under discussion here and responsible for the field defects. He felt that papilledema is probably the result of mechanical factors related to increased orbital pressure, while the optic neuropathy, because it does not correlate with severity of orbital signs, he thought might be due to some other factor, possibly ischemic edema of the nerve. This has implications in the indications for orbital decompression which the author summarized as follows: "In the first several cases of this disorder that I observed I was anxious that the patients undergo orbital decompression lest vision become irreversibly lost. When some of the patients refused this well meaning advice I was greatly relieved as was Igersheimer to learn that vision improved without this surgical aid. As I have observed more patients having this condition and as I have benefited from the reports of other physicians who have encountered similar cases, I have come to the conclusion that loss of vision due to this disorder of the optic nerves need not be considered a positive indication of decompression. On the other hand it is my feeling that for patients who have Graves' disease accompanied by papilledema, orbital decompression should be seriously considered as the treatment of choice." The tendency towards recovery of function in visual field loss of this sort is also illustrated by two cases reported by Scott; both patients recovered, one after treatment with corticotropin and one after decompression.

Hornabroock and Leonard[60] reported the interesting case of a 23-year-old woman who, after subtotal thyroidectomy, developed severe exophthalmos, rapid loss of vision, especially in the right eye, with papilledema and restricted gaze. She was started on prednisolone and triiodothyronine, and 48 hours later decompression was performed on the right orbit only. The right eye subsequently became blind. The left improved rapidly, with the vision returning to normal and papilledema subsiding. Ocular rotations became full. She was discharged on maintenance doses of thyroid and prednisolone, and after several months the prednisolone was gradually withdrawn. Five days later there was a recurrence of loss of vision in the left eye with increasing proptosis and field loss. Prednisolone was resumed, and there was much improvement within 36 hours. Her maintenance therapy included both thyroid and prednisolone.

Hoffenberg and Jackson[59] reported their experience in the treatment of five cases of progressive endocrine exophthalmos with adrenal cortical steroids. They described all five of their cases as severe and reported large doses of corticosteroids as dramatically

effective in reducing congestion and edema and more gradually in reducing exophthalmos. They do not mention the effect on ocular rotations specifically. In two cases the improvement was maintained on gradual withdrawal of the steroids, but in three other cases such large doses of cortisone (600 mg. daily) were necessary in order to maintain control that decompressive surgery was desirable.

The present status of the therapy of this condition is well illustrated by McCullagh [83] and associates who presented again their experience in the management of 39 patients with "exophthalmos of toxic diffuse goiter (Graves' disease)." Twenty of these patients were treated with triiodothyronine, ten were treated with both corticotropin (ACTH) and hydrocortisone, and nine were subjected to pituitary surgery. Of the 20 patients with progressive endocrine exophthalmos treated with triiodothyronine, the proptosis was reduced by 2 mm. or more in 9 patients, remained stationary in 9, and became worse in 2. Triiodothyronine was given in the largest doses that the patients could tolerate with comfort, usually about 100$\mu$g. per day. The 10 patients treated with corticotropin and steroid received 50 mg. of corticotropin intravenously for a period of six hours daily for from 5-16 days and 200 mg. of hydrocortisone orally daily. Hydrocortisone was reduced to maintenance levels over a period of weeks. There was immediate symptomatic improvement in all 10 patients. Conjunctival and lid swelling diminished in all but one patient. Improvement in the proptosis was apparent in only 2 of the 10 patients. In all nine patients subjected to pituitary surgery the exophthalmos improved postoperatively. In some, it disappeared entirely and visual acuity that had been extremely poor returned to normal. The authors stated that estrogens and androgens as pituitary inhibitors have been of little or no value in treatment of exophthalmos and that irradiation of the pituitary gland is also of little value, since heavy doses of this therapy do not produce hypopituitarism. Where exophthalmos is associated with hypothyroidism treatment should be started with dessicated thyroid, thyroxin, or triiodothyronine in at least physiologic doses. If exophthalmos is increasing in severity it is thought advisable to give thyroid hormone in larger than physiologic doses up to the amount that can be tolerated by the patient without undue side-effects. Where chemosis and edema are severe corticotropin and corticosteroid may be of value. Where large doses of these agents are used care should be taken to limit sodium intake and to supplement potassium intake. The use of an ulcer regime is also advisable. In severe cases of exophthalmos not responding to other measures of treatment, pituitary surgery may be considered. So far, experience with pituitary surgery is small but encouraging. In the event of rapid progression of the disease when loss of one or both eyes is threatened orbital decompression may become imperative. To the above, I would like to add that in my experience the principle value of corticotropin and steroid hormone has been not only the relief of inflammation and edema but a frequent improvement in muscle function and reduction in the troublesome symptom of diplopia. It has also been my experience that aside from the reduction in edema and inflammatory signs steroids do not produce a marked reduction in proptosis. It may be that some of the earlier unfavorable reports on the use of steroid hormones [16] were due to the fact that the observers noted the failure of reduction of proptosis but overlooked the subjective improvement, reduction in edema and congestion and improvement in ocular muscle function.

### Inflammations and Trauma

A number of case reports and clinical observations have appeared concerned with acute and chronic inflammations of the orbit and orbital trauma. Smith [124] presented five cases of orbital apex syndrome consisting of loss of vision, ptosis, diplopia, and pain. He pointed out that the condition can be due to sinus disease, in which case it

may be of sudden onset with little or no signs of inflammation and no ptosis. The symptoms are due to inflammatory compression of the structures entering the orbit through the optic foramen and the superior orbital fissure. Of the five cases presented, two were due to sinusitis of the ethmoids and sphenoids, two to tumor, and one to hemorrhage secondary to trauma. Erdmann [36] presented the case of a 7-week-old infant who developed proptosis due to an orbital abscess secondary to a purulent infection of the ethmoids and antrum. The condition subsided when the abscess was drained and the infection was treated. Hartmann [54] reported two cases of orbital fistula and empyema of the frontal sinus, one of which was thought to be tuberculous. The author advised radical excision of the frontal sinus as the preferred treatment. Sebestyen [116] analyzed the therapeutic results in the treatment of acute inflammation of the orbit before and after antibotics and chemotherapy. He found that surgical intervention can now be dispensed with in many cases. The incidence of blindness and a previous mortality rate of considerable proportions have now been reduced by the use of antibiotics and sulfa.

Several clinicians presented their experience with the management of pseudotumor of the orbit. Vancea [140] reported the case of a 33-year-old patient with inflammatory pseudotumor lasting four years. There was exophthalmos, papilledema, myositis, and orbital cellulitis. Biopsy specimen revealed a nodular perivascular infiltration, edema, and modification of muscle fibers. The lesion was resistant to treatment with antibiotics but eventually cleared spontaneously. Valenzuela [136] reported two cases of chronic orbital granuloma treated by x-ray. One of these had been present for 8 years, and both responded with a regression of exophthalmos and improvement in visual acuity. The author suggested that radiation inhibits the vascular elements of the tissue and destroys lymphoid elements. Rosselet [109] reported his technique for irradiation of the orbit in cases of malignant exophthalmos and inflammatory pseudotumor. Papst [97] and associates, in the first of two papers dealing with pseudotumor of the orbit, described seven cases, three of which became blind on the affected side and showed optic atrophy. All responded well to corticosteroids. These authors studied the electromyogram of their patients and described a myopathic pattern which they found helpful in differentiating the condition from other lesions. Niessen [92] also reports a chronic case of pseudotumor which improved rapidly with retrobulbar cortisone injections.

Several case reports have appeared dealing with sarcoid of the orbit. Smith [125] reported the 10th case of orbital sarcoid in a 65-year-old Negro woman with proptosis and pain in the left eye for one month. Laboratory work was not remarkable, but radioactive phosphorous localization revealed a tumor mass in the posterior portion of the left orbit. The orbit was explored and a small tumor found in relation to the medial rectus muscle posteriorly. Histologically, this was typical of sarcoid. She was treated with prednisone (Meticorten), 15 mg. daily for seven months, with gradual regression of the proptosis. Because of the frequently self-limiting nature of the disease the author cautioned that, while steroid therapy appeared beneficial, its true value remains undetermined. Blatt [13] and associates presented an 11th case, occurring in a 16-year-old girl, in which proptosis of the right eye due to an orbital mass led to corneal perforation requiring enucleation. Jensen [62] added two cases which appeared as rapidly growing ill-defined orbital masses. He points out that these cases could easily be mistakened clinically for orbital tumors.

Fungus infections of the orbit are rare, but occasional case reports continue to appear. Viers and Davis [143] reported two cases of orbital mycosis, one due to Aspergillus and one to an actinomyces. Tikhomirov [133] reported the case of a 36-year-old woman with an Aspergillus abscess of the roof of

the orbit that had eroded the bone and extended intracranially. Initial symptoms were swelling of the right side of the face with limitation of ocular rotation. X-ray revealed the destruction of the roof of the orbit. The patient developed right hyposmia, facial paralysis, inequality of deep reflexes, and progressive weakness and apathy. The specific diagnosis was established at autopsy.

Goodman and Pond [49] studied an interesting patient, a 13-year-old girl who developed pain, lid swelling, and intermittent proptosis of first one eye and then the other over a four-week period. The condition did not respond to antibiotics but subsided promptly on systemic prednisolone. Sinus infection, blood dyscrasia, and metazoan infestation were excluded, and the final diagnosis was serous tenonitis of rheumatic origin.

Benedict [8] reported a remarkable case of angioneurotic edema of the orbit. The patient was a 40-year-old white woman who had had recurrent attacks of pain and localized swelling of the eyelids and face since the age of 13. These attacks occur at intervals of one to three weeks. In 1944 (at the age of 25), she was given a series of x-ray treatments to the orbits. Since then the attacks have been confined to the right eye, and she now has persistent exophthalmos and limitation of motion on that side. During attacks the proptosis increases 4-5 mm., papilledema is present, and vision is reduced to light perception. Between attacks proptosis diminishes, pain disappears, the papilledema subsides, and vision returns to normal. Extensive search for an exciting agent has been negative, and the condition is refractory to all treatment. Benedict stated that this is a rare disease usually found in children and young adults who are demonstrably allergic to foods, infections, light, and climate. Most cases are mild, but severe attacks of edema lead to optic neuritis, papilledema, glaucoma, hemianopsia, deafness, convulsions, and a variety of peripheral palsies. Patients often recover after withdrawal of food or milk or removal of infection and intestinal parasites. While recovery is the rule when the exciting agent can be removed, some cases become chronic, resulting in permanent paralysis of the eye muscles and alteration in the field of vision or partial blindness.

Two papers have appeared on the rare Albers-Schonberg's disease, also known as marble bone disease or osteopetrosis. This is a hereditary affliction of unknown etiology which is characterized by increased density of many of the bones of the body including the long bones, pelvis, and bones of the skull. When its onset is early in life thickening of the sphenoid bone may lead to optic atrophy, while adult cases are usually characterized by a tendency towards pathologic fracture. Pietruschka,[100] in an addition to an earlier paper, added a fourth case that has come under his observation. This was a 22-year-old girl who, like the other cases, showed the characteristic triad of optic atrophy, exotropia, and exophthalmos. Dejean [32] and associates reported a diffuse osteopetrosis of the orbital and nasal bones in a 67-year-old man with bilateral exophthalmos. This patient was also syphilitic, so that there is a question as to whether it should not be considered as an example of syphilitic periostitis.

Smith [125] presented again the material, gathered by him and Regan, concerned with the hydraulic mechanism of internal orbital fractures, so-called "blow-out fracture of the orbit." He continued to advocate early surgical correction to prevent later deformity and described the use of otogenous bone grafts. Copper [27] reviewed the clinical features of orbitocranial stab wounds, pointing out that there may be great danger inherent in stab wounds wherein the external wound may look minor and there may be no intracranial signs of penetration for the first 24 hours or so. He advised a careful history of the manner of injury and the type of object involved and found that this usually gives an indication of a potentially deep wound. Careful x-ray visualization for foreign body or fracture of orbital walls is also essential. Chams and Sadoughi [21] reported three cases of unusual foreign-body injury involving the knob of

a drawer, the point of a knife, and a portion of a metallic weapon. The cases were remarkable in that despite the severity of the wounds and size of the foreign bodies the eye and vision remained intact.

### Surgery

Lagrot[96] and associates discussed the causes of symblepharon and contracted sockets and compared the value and usefulness of mucous-membrane grafts and skin grafts. For the correction of contracted socket the authors preferred a technique wherein a split is made inferiorly and the incision carried down to the inferior orbital margin behind the lower lid. A petrolatum-gauze stint is fashioned and used to hold a mucous-membrane graft from the cheek or prepuce. They reported good results in 26 of 30 cases. In one other case a failure followed the attempted use of a conjunctival homograft from a cadaver.

Bellizzi[7] reviewed the classical technique of exenteration and pointed out some of its inadequacies, particularly the slow epithelialization of the socket. This author now uses Thiersch grafts to cover the entire orbit in all cases. He finds recovery accelerated and the patients more comfortable and free of complications. McLaren[86] reported on primary skin grafting after exenteration of the orbit in 10 cases and described his technique for the application of thin sheets of split skin directly to the bare bone of the orbit free of periosteum. Satisfactory takes were obtained, and healing was complete in 14 days in all but one case.

Reese[105] presented a modification of orbital exenteration with temporalis muscle transplant that appears to offer very definite advantages. In the classical exenteration of the orbit a deep and unsightly cavity is produced which is most objectionable to patients. In addition, even with Thiersch grafts postoperative dressings are usually required for a period of six to eight weeks. To avoid these two complications Reese noted that the deep fascia covering the temporalis muscle is even thicker than the muscle itself and that a better filling of the orbital defect results if the fascia is transplanted with the muscle instead of being left behind as was done in the earlier technique originally reported by Naquin.[91] In Reese's hands, the lid margin and lash line are retained and a horizontal incision is extended from the lateral canthus exposing the temporalis muscle. Exenteration is done leaving the periosteum intact, except in the one quadrant of the tumor area where the periosteum is removed. The temporalis is severed from its origin at the zygomatic arch, and a complete dissection of the muscle and its fascia is carried down to its insertion in the coronoid process of the mandible. When the muscle is sufficiently mobilized it is passed into the orbit through an opening in the lateral wall made with the Stryker saw and rongeurs. The muscle is spread out and sutured to the remaining periosteum. The lids are sutured, and a pressure dressing is applied. Reese listed the following advantages of this procedure: (1) a much better cosmetic result, since the orbit is filled out and the previous unsightly cavity is avoided; (2) postoperative dressings are necessary for only 7-10 days; (3) retention of the lid and cilia lines makes possible a reconstruction of the socket in which a prosthesis might be worn. Reese plans in the future to make the reconstructive graft over a dental stint a part of the primary procedure. In a footnote he also mentioned a case in which a 20 mm. gold ball was placed in the apex of the orbit and was well tolerated, producing even better filling of the orbital cavity. Several papers on the various techniques of orbital implant after enucleation have appeared. In the Latin American literature Marin-Amat[76] and Schneider[114] each discussed results of orbital implants following the technique of Arruga. In both instances the authors felt that there were little or no advantages over older techniques. Gebertt[45] has devised a new implant with four gold prongs that extend to the surface for attachment of the exoplant. He has used

the technique in 13 cases, in 3 of which the implant had to be removed. It is difficult to see how this implant might be able to avoid the disadvantages of previous integrated implants. Dr. A. D. Ruedemann Sr.[111] described the technique of evisceration which he has used for 25 years with successful results in over 95% of 200 cases. The conjunctiva and sclera are incised through 180 degrees from 9 to 3 o'clock about 8-10 mm. behind the cornea and anterior to the superior rectus muscle. The contents of the globe are eviscerated, and special precautions are taken to remove all shreds of the uveal tissue. Bleeding is controlled by cautery, and the eye is wiped out with iodine and irrigated with alcohol and then with saline. An 18-19 mm. polyethylene sphere is inserted, and the sclera and conjunctiva are tightly sutured with 000 absorbable surgical (gut) suture. The principle complication of the technique is postoperative reaction and discomfort with edema, conjunctival reaction, and pain which may last for several weeks or months. Thereafter a prosthetic shell is worn which is fitted like a contact lens. Dr. Ruedemann lists the advantages of this procedure as (1) less psychological trauma to the patient and (2) an excellent cosmetic result with the best possible movement of any prosthetic appliance. Verzella[146] used a similar technique but implanted a 10 mm. acrylic ball that contains a metallic pivot on its posterior surface.

Reports continue to appear in the ear-nose-and-throat literature describing the advantages of transantral decompression of the orbit for malignant exophthalmos.[149,150] The advantages listed are a relatively atraumatic procedure which may be done under local anesthesia with a short convalescence and no postoperative deformity. There is no external incision and a 4-7 mm. regression of exophthalmos can usually be obtained. Some of the possible disadvantages foreseen would include occasional instances of infection, limited decompression, and residual numbness of the face.

### Vascular Condition of the Orbit

Thurel[132] presented an interesting case report of a 40-year-old woman who sustained a basal skull fracture in a bicycle accident. This was followed by a severe bilateral exophthalmos with chemosis, ophthalmoplegia, and loss of vision closely resembling malignant exophthalmos. Angiograms and the presence of a bruit revealed a carotid cavernous fistual on the left. Ligation of the left common carotid was followed by rapid improvement. Constantinovits[25,26] presented the case of a 43-year-old plumber who had a monocular intermittent exophthalmos due to a retrobulbar varix. This was excised through a Kronlein approach, with regression of the exophthalmos and good vision maintained throughout an eight-year follow-up. Calmettes[19] reported a curious case of inflammatory exophthalmos associated with hemorrhagic colitis. The author suspected venous thrombosis as a possible cause. Hager[51] reported the case of a 55-year-old woman who had had intermittent exophthalmos 30 years previously due to orbital varices. X-ray revealed 10 phleboliths in the left orbit, and histologic examination of one of them revealed organized and calcified venous thrombosis.

Stanford Medical Plaza, Suite B-7, Welch at Pasteur.

### REFERENCES

1. Adams, D. D.: The Presence of an Abnormal Thyroid-Stimulating Hormone in the Serum of Some Thyrotoxic Patients, J. Clin. Endocrinol. 18:699-712 (July) 1958.

2. Asboe-Hansen, G.: Hormonal Effects on Connective Tissue, Physiol. Rev. 38:446-462 (July) 1958.

3. Selenkow, H. A., Jr., and Asper, S. P.: Effectiveness of Triiodothyronine or Thyroxine Administered Orally in the Treatment of Myxedema, J. Clin. Endocrinol. 15:285-296 (March) 1955.

4. Bahn, G. C., and Hauser, G.: A Review of Orbital Tumors, South. M. J. 51:1444-1447 (Nov.) 1958.

5. Barber, A. N.: Inheritance of Congenital Anophthalmia in Mice, Am. J. Ophth. 46:893 (Dec.) 1958.

6. Barthelmess, G.: Coordimetry in Displacement of the Eyeball, Klin. Monatsbl. Augenh. 131: 662-668, 1957.

7. Bellizzi, A. M.: Technique of Epithelization of the Orbit in Exenterated Patients: Critical Study of 55 Cases, Rev. brasil. oftal. 17:301-345 (Sept.) 1958.

8. Benedict, W. L.: Angioneurotic Edema of Orbit, Am. J. Ophth. 45:43-46 (April, Pt. 2) 1958.

9. Bertelsen, T. I., and Petersen, O.: Orbital Pneumography, Acta radiol. 47:426-432 (June) 1957.

10. Beuerman, V. A., and Tabor, G. L., Jr.: Primary Tumors of the Orbit, with Case Reports, Am. J. Ophth. 46:501-508 (Oct.) 1958.

11. Bierwaltes, W. H., and Ruff, G. E.: Thyroxin and Triiodothyronine in Excessive Dosage to Euthyroid Humans, A. M. A. Arch. Int. Med. 101:569-576 (March) 1958.

12. Birnmeyer, G.: Special Forms of Protrusio Bulbi into the Orbit in Chronic and Subacute Frontal Sinusitis, Ztschr. Laryng. Rhin. Otol. 37: (May) 1958.

13. Blatt, N.; Alexandru, U.; Athanasie, M.; Mauresan, I., and Popovici, V.: Orbital Bone Involvement in Besnier-Boeck-Schaumann Sarcoid, Am. J. Ophth. 45:407-414 (March) 1958.

14. Bottari, P. M.: The Estimation of Thyrotropic Hormone in the Sera of Normal Patients and Those with Thyroid Disease, J. Endocrinol. 17:xix, 1958.

15. Bottari, P. M., and Donovan, B. T.: A Sensitive in Vitro Technique for the Assay of Thyrotropic Hormone, J. Physiol. 140:36P-37P (Feb. 17) 1958.

16. Brain, R.: Cortisone in Exophthalmos: Report on a Trial of Cortisone and Corticotropin (ACTH) in Exophthalmos and Exophthalmic Ophthalmoplegia by a Panel Appointed by the Medical Research Council, Lancet 1:6-9 (Jan. 1) 1955.

17. Brini, A.: L'Exophtalmie maligne endocrinienne, Strasbourg Méd. 9:74-86 (Jan.) 1958.

18. Broschmann, D.: Corneal and Conjunctival Sensitivity Disorders in Endocrine Exophthalmos, Klin. Monatsbl. Augenh. 132:311-322, 1958.

19. Calmettes, L.; Déodati, F., and Bec, P.: Unilateral exophthalmus during hemorrhagic recto colitis. Arch. opht. 18: (April-May) 1958; Rev. oto-neuro-opht. 30:207-209, 1958.

20. Carey, P. C.: Epidermoid and Dermoid Tumours of the Orbit, Brit. J. Ophth. 42:225-239 (April) 1958.

21. Chams, G., and Sadoughi: Trois cas curieux de corps étrangers extra-oculaires, Acta med iran. 2:53-55 (Aug.) 1958.

22. Chatterjee, B. M.: Osteoma of the Orbit, Am. J. Ophth. 46:392-395 (Sept.) 1958.

23. Cohen, E. I.: Thyrotropic exophthalmos, clinical forms and neurologic aspect, Presse méd. 66:1040 (June 11) 1958.

24. Cohen, E. I.: Residual Exophthalmos, Folia endocrinol. 11:185-190 (April) 1958.

25. Constantinovits, M., and Guszich, A.: Exophthalmos Intermittent: A Surgically Cured Case, Szemészet 94:149-155, 1958.

26. Constantinovits, M., and Guszich, A.: Exophthalmos: A Case Cured by Surgery, Beitr. klin. Chir. 195:362-371 (Nov.) 1957.

27. Copper, A.: Orbital Cranial Stab Wounds, Ophthalmologica 134:366-372 (Nov.) 1957.

28. Cordes, F.: Endocrine Exophthalmos, an Evaluation of Present Knowledge, Am. J. Ophth. 38:1-21 (July) 1954.

29. Crudeli, R.: Meningioma of the Optic Foramen (Case Report), Ann. ottal. 84:238-244 (May) 1958.

30. Damany, B. J., and Gokhale, A. M.: Unilateral Exophthalmos, J. Indian M. A. 30:19-20 (Jan.) 1958.

31. Deiss, W. P., Jr.; O'Shaughnessy, P. J., and Wynn, J. O.: Early Effects of Thyrotropin on $PBI^{131}$ Release and on Plasma $Iodide^{131}$ Disappearance, Am. J. Med. 25:117 (July) 1958.

32. Dejean, C.; Viallefont, H.; Boudet, C., and Boulad: Ostéopétrose syphilitique diffuse orbito-nasale: Exophtalmie bilaterale, Rev. oto-neuro-opht. 29:440-442, 1957.

33. De Laey, A., and Van Wymeersch, H.: A propos de deux Cas de mucocèle frontale, à complications orbito-oculaires, parmi des marins noirs, Ann. Soc. belge méd. trop. 37:459-467 (Aug.) 1957.

34. Dobyns, D. M.: An Exophthalmos Producing Substance in the Serum of Patients Suffering from Progressive Exophthalmos, J. Clin. Endocrinol. 14:1393-1402 (Nov.) 1954.

35. Dyer, J. A., and Henderson, J. W.: Orbitonometry in Unilateral Exophthalmos, Am. J. Ophth. 45:208-221 (Feb.) 1958.

36. Erdmann, H., and Erdmann, R.: Orbital Complications with Sinus Affections in Infants, Klin. Monatsbl. Augenh. 132:559-566, 1958.

37. Ferrer Arata, A.; Gómez Morales, A., and de Guzmán y Heredia, L. N.: Orbitonometry in Orbital Tumors, Arch. oftal. Buenos Aires 32:319-332 (Dec.) 1957.

38. Fourcade, C. H.: Radiological Aspects of Orbital Pneumatocele; Two Case Reports, Bull. Soc. opht. France, February, 1958, pp. 107-110.

39. François, J.: Clinical Manifestations of Exophthalmos, Belg. tijdschr. geneesk. 14:590-594 (June 15) 1958.

40. François, J.; Hoffman, G.; Verriest, G., and Candaele, N.: Nocardiose à localisation pulmonaire, intracrânienne et orbitaire, Acta neurol. et psychiat. belg. 57:792-802 (Oct.) 1957.

41. Fregni, R., and DePoli, A.: Clinical Study of Orbital and Paranasal Tumors, Arch. ital. otol. 68:333 (Supp. 33) 1957.

42. Friis, T., and Chapman, E. M.: Euthyroid Patients with Exophthalmos: Examination by Means of Conversion Ratio and Paper Chromatography, Ugesk. læger 119:1539-1548 (Nov. 28) 1957.

43. Friis, T., and Chapman, E. M.: Function of Thyroid in Patients with Exophthalmos, Acta endocrinol. 27:207-215 (Feb.) 1958.

44. Fryd, C. H., and Hauer, J.: Observations on Hyperthyroidism and Exophthalmos, Acta med. oriental. 16:160-167 (Aug.) 1957.

45. Gebertt, S.: Buried Orbital Implant with Extra-Conjunctival Extension, Brit. J. Ophth. 42: 54-59 (Jan.) 1958.

46. Giacomelli, P.: A Case of Congenital Anophthalmos, Gior. ital. oftal. 10:67-76 (Jan.-Feb.) 1957.

47. Girard, L. J.; Fountain, E. M.; Moore, C. M., and Thomas, J. R.: Teratoma of the Orbit, Tr. Am. Acad. Ophth. 62:226-233 (March-April) 1958.

48. Girard, P. F.; Bonamour, G., and Robert, J. M.: Malformations of the Base of the Cranium in von Recklinghausens Disease with Reference to a Case of Orbital Defect with Exophthalmos, Lyon méd. 90:131-138 (Aug. 3) 1958.

49. Goodman, E., and Pond, M. J.: Serous Tenonitis, A. M. A. Arch. Ophth. 59:899-900 (June) 1958.

50. Goodside, V.: Monocular Proptosis as the Initial Finding in Chronic Lymphatic Leukemia, New York J. Med. 58:4075-4076 (Dec. 15) 1958.

51. Hager, G.: Phleboliths in the Orbit, von Graefes Arch. Ophth. 159:662-666 (April) 1958.

52. Hale, F.: Pigs Born Without Eyeballs, J. Hered. 24:105 (Jan.) 1933.

53. Hamilton, H. E.; DeGowin, E. L., and Schultz, R. O.: A Disparity in Progress of Exophthalmos, Lid Spasm, Soft Tissue Reaction, and Extraocular Myopathy in Patients Treated for Thyrotoxicosis with $I^{131}$, J. Lab. & Clin. Med. 52: 817 (Nov.) 1958.

54. Hartmann, K.: Orbital Fistula in Empyema of the Frontal Sinus, Klin. Monatsbl. Augenh. 133: 706, 1958.

55. Hedges, T. R., Jr., and Scheie, H. G.: Visual Field Defects in Exophthalmos Associated with Thyroid Disease, A. M. A. Arch. Ophth. 54:885-892 (Dec.) 1955.

56. Henderson, J. W.: The Problem of Progressive Exophthalmos in Thyroid Disease, J. Michigan M. Soc. 56:849-853 (July) 1957.

57. Henderson, J. W.: Optic Neuropathy of Exophthalmic Goiter (Graves' Disease), A. M. A. Arch. Ophth. 59:471-480 (April) 1958.

58. Hicks, S. P.: Mechanism of Radiation Anencephaly, Anophthalmia, and Pituitary Anomalies, A. M. A. Arch. Path. 57:363-378 (May) 1954.

59. Hoffenberg, R., and Jackson, W. P. U.: Adrenocortical Steroids in Malignant Exophthalmos, Lancet 1:693-695 (March 29) 1958.

60. Hornabrook, R. W., and Leonard, J. E.: Adrenocortical Steroids in Malignant Exophthalmos, Letter to the Editor, Lancet 1:854 (April 19) 1958.

61. Igersheimer, J.: Visual Changes in Progressive Exophthalmos, A. M. A. Arch. Ophth. 53: 94-104 (Jan.) 1955.

62. Jensen, V. J.: Sarcoidosis of the Orbit, Acta ophth. 35:416-509, 1957.

63. Khramelashview, N. D.: Exophthalmos of the Left Eye Caused by a Tumor of the Cheek, Vestnik oftal. 70:41-42 (Nov.-Dec.) 1957.

64. Kleberger, E., and Stolowsky, R. B.: An Unusually Large Orbital Cyst with Marked Enlargement of the Bony Orbit, Klin. Monatsbl. Augenh. 133:218, 1958.

65. Krayenbühl, H.: Diagnostic Value of Orbital Angiography, Brit. J. Ophth. 42:180-190 (March) 1958.

66. Lagrot, F.; Py, N.; Alcayde, M., and Lavergne, E.: Réfection des cavités orbitaires et des culs-de-sac conjunctivaux, Arch. opht. 17:769-781 (Dec.) 1957.

67. Langford, H. G.: Production of Exophthalmos in Fundulus Heteroclitis by Triiodothyronine and Dessicated Thyroid, Endocrinol. 60: 390-392 (March) 1957.

68. Langmaid, C., and Daws, A.: Pulsating Exophthalmos in von Recklinghausen's Disease, J. Neurol. & Psychiat. 21:42-46 (May) 1958.

69. Larsen, G.: The Viscosity of the Vitreous Humor Influenced by Hormones, A. M. A. Arch. Ophth. 59:712-716 (May) 1958.

70. Lazorthes, G.; Geraud, J.; Anduzeacher, H., and Espagnb, J.: L'Exophthalmie unilatérale neurochirurgicale: Analyse de 32 observations, Bull. Soc. opht. France, August-October, 1957, pp. 524-527.

71. Lederman, M.: Technique of Radiation Treatment of Orbital Tumors, Brit. J. Radiol. 30: 469-476 (Sept.) 1957.

72. Lindner, K.: Coagulation of Dermoid Cysts with 30% Trichloracetic Acid, Klin. Monatsbl. Augenh. 131:669-670, 1957.

73. Lorenzen, U. K.: Plasmacytoma of the Orbit, Klin. Monatsbl. Augenh. 132:731, 1958.

74. Luft, R., and Nilsson, L. B.: Exophthalmos: V. Internal Medical Factors, Svenska Läk. 54:3126-3130 (Oct. 18) 1957.

75. Lyle, D. J.: Treatment of Exophthalmos as Viewed by the Ophthalmologist, Ann. Roy. Coll. Surgeons England 21:203-216 (Oct.) 1957.

76. Marin-Amat, M.: Capsuloscleral Implants, Arch. Soc. oftal. hispano-am. 17:625-628 (June) 1957.

77. Maroncelli, P., and Pace, M. C.: Malignant Endocrine Exophthalmos: A Clinical and Etiopathogenic Study of a Case of Monolateral Progressive Exophthalmos, Policlinico (sez. prat.) 64: 1901-1909 (Dec. 2) 1957.

78. De Marsillas, J., and Bellizzi, A. M.: Primary Osteogenic Sarcoma of the Orbit, Arch. brasil. med. 19:7059 (July-Sept.) 1958.

79. Mårtensson, G.: Exophthalmos: IV. Diseases of Paranasal Sinuses with Orbital Involvement, Svenska läk. 54:3123-3126 (Oct. 18) 1957.

80. Masseboeuf, A.; Acquaviva, R., and Thevenot, C.: Exophtalmies unilatérales traitées en milieu neurochirurgical, Maroc. méd. 36:945-962 (Oct.) 1957.

81. Mathur, S. P.: Chloroma of the Orbit, Am. J. Ophth. 47:91-93 (Jan.) 1959.

82. Matty, A. J.; Menzel, D., and Bardach, J. E.: The Production of Exophthalmos by Androgens in 2 Species of Teleost Fish, J. Endocrinol. 17:314 (Sept.) 1958.

83. McCullagh, E. P.; Clamen, M.; Gardner, W. J.; Kennedy, R. J., and Lockhart, G., III: Exophthalmos of Grave's Disease: A Summary of the Present Status of Therapy, Ann. Int. Med. 48: 445-470 (March) 1958.

84. McHugh, J. J., and Mellinger, R. C.: Progressive Exophthalmos Developing 12 Years After Thyroidectomy for Diffuse Toxic Goiter, Ann. Int. Med. 49:955-958 (Oct.) 1958.

85. McKenzie, J. M.: The Bioassay of Thyrotropin in Serum, Endocrinology 63:372-383 (Sept.) 1958.

86. McLaren, L. R.: Primary Skin Grafting After Exenteration of the Orbit, Brit. J. Plast. Surg. 11:57-61 (April) 1958.

87. Merriam, G. R., and Focht, E. F.: Radiation Dose to the Lens in Treatment of Tumors of the Eye and Adjacent Structures, Radiology 71:357-369 (Sept.) 1958.

88. Merz, M.: Visual Apparatus and Pituitary Hypothalnic System, Klin. oczna 27:629-636, 1957.

89. Millard, D. R.: Simple Repair of Orbit Margin Defects, Am. J. Ophth. 46:486-488 (Sept., Pt. 1) 1958.

90. Morgan, D. C., and Mason, A. S.: Exophthalmos in Cushing's Syndrome, Brit. M. J. 2:481-483 (Aug. 23) 1958.

91. Naquin, H.: Exenteration of the Orbit, A. M. A. Arch. Ophth. 51:850-862 (June) 1954.

92. Niessen, V.: The Treatment of Orbital Pseudotumor with Local Cortisone, Klin. Monatsbl. Augenh. 133:97-101, 1958.

93. Nover, A., and Zielinski, H. W.: Differential Diagnosis of Orbital and Optic Nerve Tumors, Klin. Monatsbl. Augenh. 131:577-598, 1957.

94. Olivecrona, H., and Bohm, E.: Exophthalmos: III. Transcranial Operation for Retrobular Tumors, Svenska läk. 54:3119-3122 (Oct. 18) 1957.

95. Pagani, L.: Ocular Plasmocytoma, Rass. ital. ottal. 26:364-375 (Sept.-Oct.) 1957.

96. Pajor, R.: Cholesteatoma of the Orbit, Klin. Monatsbl. Augenh. 132:248-252, 1958.

97. Papst, W.; Mertens, H-G., and Esslen, E.: Chronic Ocular Myositis: Exophthalmic Myositis, Klin. Monatsbl. Augenh. 133:673, 1958.

98. Pasmanick, S.: Orbital Lymphosarcoma, Arch. chilen. oftal. 39:110 (July-Dec.) 1957.

99. Patterson, J. B.: Congenital Orbital Deformity: A Case Report, Plast. & Reconstruct. Surg. 22:271 (Sept.) 1958.

100. Pietruschka, G.: Further Comments on the Marble Bone Disease, Klin. Monatsbl. Augenh. 132:509, 1958.

101. Pinto, F.: Blastoma of the Orbit Tissue: Extirpation by Transcranial Approach, Rev. brasil. cir. 34:92-96 (July) 1957.

102. Plotz, C. M.; Knowlton, A. I., and Ragan, C.: The Natural History of Cushings's Syndrome, Am. J. Med. 13:597-614 (Nov.) 1952.

103. Pollack, I.; Constant, M. A.; Rosenbaum, H., and Becker, B.: Preliminary Assay Studies in the Minnow of Exophthalmos-Producing Substance, Am. J. Ophth. 45:930 (June) 1958.

104. Pritkin, R. I.: Anopthalmos, Am. J. Ophth. 45:714-715 (May) 1958.

105. Reese, A. B.: Exenteration of the Orbit, with Transplantation of the Temporalis Muscle, Am. J. Ophth. 45:386-390 (March) 1958.

106. Reese, A. B.: The Treatment of Expanding Lesions of the Orbit with Particular Regard to Those Arising in the Lacrimal Gland, Am. J. Ophth. 41:3-11 (Jan.) 1956.

107. Rendahl, I.: Exophthalmos: II. Retrobulbar Tumors and Their Surgical Therapy, Svenska läk. 54:3115-3118 (Oct. 18) 1957.

108. Rose, E.: Endocrine Aspects of the Exophthalmic Ophthalmopathy, Klin. Wchnschr. 36: 145-147 (Feb.) 1958.

109. Rosselet, P. J.: Exophthalmos and Radiotherapy, Radiol. clin. 26:250-253 (Sept.) 1957.

110. Rouher, F.: La Biopsie est-elle opportune dans les réticulo-sarcomes de l'orbite chez l'enfant, Bull. et mém. Soc. franç. opht. 70:423-435, 1957.

111. Ruedemann, A. D., Sr.: Evisceration with Retention of the Cornea, Am. J. Ophth. 45:433-434 (March) 1958.

112. Sanna, G.: Case of Circumscribed Intraorbital Tuberculoma: Clinical and Histological Findings, Ann. ottal. 84:123-135 (March) 1958.

113. Schaposnik, F.: Multiple Myeloma: Unilateral Exophthalmos, Dia médico Buenos Aires 29:3185 (Nov. 28) 1957.

114. Schneider, O.: Orbital Implants Following the Technique of Arruga-Maura, Arch. chilen. oftal. 14:24-28 (Jan.-June) 1957.

115. Scott, G. I.: Ocular Aspects of Endocrine Exophthalmos, Brit. J. Ophth. 42:173-179 (March) 1958.

116. Sebestyen, J.: Results of Treatment in Acute Orbit Inflammation, Klin. Monatsbl. Augenh. 132:480-486, 1958.

117. Seltzer, A. P.: Exophthalmos as Seen by the Rhinologist, J. Nat. M. A. 50:107-108 (March) 1958.

118. Shtulman, D. R.: Problems of Pathogenesis of Malignant Exophthalmos, Sovetskaia Med. 22:6-38 (June) 1958.

119. Smelser, G. K., and Ozanics, V.: Hydrophilia of the Orbital Connective Tissue in Experimental Exophthalmos, Am. J. Ophth. 47:380-386 (Jan.) 1959.

120. Smelser, G. K., and Ozanics, V.: Studies on the Nature of Exophthalmos-Producing Principle in Pituitary Extracts, Am. J. Ophth. 38: 107-122 (July, Pt. 2) 1954.

121. Smelser, G. K., and Ozanics, V.: Further Studies on the Nature of Exophthalmos-Producing Principles in Pituitary Extracts, Am. J. Ophth. 39:146-155 (Feb., Pt. 2) 1955.

122. Smelser, G. K., and Ozanics, V.: The Relation of the Adrenal Gland to Experimental Production of Exophthalmos, Am. J. Ophth. 45: 292 (Feb.) 1958.

123. Smith, A. T.: Orbital Apex Syndrome, Ann. Otol. Rhin. & Laryng. 67:742-753 (Sept.) 1958.

124. Smith, B.: Diplopia in Depressed Orbital Fractures, Plast. & Reconstruct. Surg. 20:318-322 (Oct.) 1957.

125. Smith, W. A.: Boeck's Sarcoid of the Orbit: Report of a Case Receiving Questionable Benefit from Steroid Therapy, Am. J. Ophth. 45:567-569 (April) 1958.

126. Sommerville-Large, L. B., and O'Meara, R. A. Q.: Malignant Synovioma of the Superior Oblique, Am. J. Ophth. 45:631-636 (May) 1958.

127. Spaeth, E. B., and Valdes-Dapena, A.: Recurrent Hemangiopericytoma of the Orbit, A. M. A. Arch. Ophth. 60:1070-1073 (Dec.) 1958.

128. Spanyol, V.: Therapy of Orbital Angiomas by Puncture or Aspiration of Blood Contents, Klin. Monatsbl. Augenh. 131:448-451, 1957.

129. Stanokovic, I., and Litricin, O.: Eosinophilic Granuloma of Orbit, Srpski arhiv 86:357-363 (March) 1958.

130. Stockard, C. R.: The Influence of Alcohol and Other Anesthetics on Embryonic Development, Am. J. Anat. 10:369-392, 1910.

131. Thiébaut, F.; Philippidès, D.; Isch, F., and Collard, M.: Late Epilepsy and Left Exophthalmos Symptomatic of a Fronto-Orbital Meningioma, Rev. oto-neuro-opht. 29:431-432, 1957.

132. Thurel, M. R.: Carotid Cavernous Fistula and Bilateral Exophthalmos, Neurochirurgia 4:141 (April-June) 1958.

133. Tikhomirov, P. E.: Mycosis of the Orbit Simulating Malignant Tumor, Vestnik oftal. 71: 44-48 (Jan.-Feb.) 1958.

134. Toppozada, H. H.: Ganglioneuroma of the Left Maxilla and Orbit, J. Laryng. & Otol. 72: 733-742 (Sept.) 1958.

135. Ugelli, L., and Pollizzi, F.: Report on 2 Cases of Hydatid Cyst of the Orbit, Minerva neurochirurg. 2:58 (April-June) 1958.

136. Valenzuela, R.: Exophthalmos Due to Chronic Orbital Granuloma, Arch. chilen. oftal. 39:127 (July-Dec.) 1957.

137. Valu, L.: Multiple Lipoma of Unusual Form and Topography in the Orbital Cavity, Szemészet 94:81-83, 1958.

138. Vancea, P.: Bilateral Orbital Cysts, Ophthalmologica 134:405-409 (Nov.) 1957.

139. Vancea, P.; Triandof, E.; Dobrescu, G., and Cernea, P.: A Polycystic Teratoma of the Orbit, Ann. ocul. 191:670 (Sept.) 1958.

140. Vancea, P., and Vaighel, U.: Bilateral Exophthalmos with Papillary Stasis from Myositis and Orbital Cellulitis of Undetermined Cause, Arch. opht. 17:791-798 (Dec.) 1957.

141. Vannini, A., and Pettinati, S.: Simultaneous Radiographic Study of the Orbital Veins and Tomography, Rass. ital. ottal. 26:87-90 (March-April) 1957.

142. Vannini, A., and Pettinati, S.: Clinical and Radiological Considerations in Congenital Exophthalmos, Rass. ital. ottal. 26:214-225 (May-June) 1957.

143. Viers, E. R., and Davis, C. T.: Fungus Infection of the Eye and the Orbit, A. M. A. Arch. Ophth. 59:172-176 (Feb.) 1958.

144. Venclik, H.; Pitter, J., and Svoboda, M.: Periodicky exofthalmus, Ceskoslov. oftal. 14:195-197 (June) 1958.

145. Vergez, A.: Les voies temporales d'abord de l'orbite, Arch. opht. 18:148-184 (March); 294-343 (April-May), 1958.

146. Verzella, M.: Intrascleral Implant of Acrylic Sphere with Metallic Stem, Rass. ital. ottal. 26:246-264 (July-Aug.) 1957.

147. Volpi, U., and Bertoncini, G.: A Case of Eosinophilic Granuloma of the Orbit, Bull. ocul. 37:440 (June) 1958.

148. Wolff, J., and Austen, F. K.: Salicylates and Thyroid Function: II. The Effect on the Thyroid-Pituitary Interrelation, J. Clin. Invest. 37:1144-1152 (Aug.) 1958.

149. Walker, J. S., and Porter, G. L.: Transantral Decompression for Malignant Exophthalmos, A. M. A. Arch. Otolaryng. 68:152-155 (Aug.) 1958.

150. Walsh, T. E., and Ogura, J. H.: Trans-Antral Decompression for Malignant Exophthalmos, Tr. Am. Laryng. Rhin. Otol. Soc. 61:56-81, 1957.

151. Weekers, R., and Lavergne, G.: A New Symptom of Thyrotropic Exophthalmos, Ophthalmologica 134:276-282 (Oct.) 1957.

152. Weekers, R., and Lavergne, G.: Changes in Ocular Rigidity in Endocrine Exophthalmos, Brit. J. Ophth. 42:680-685 (Nov.) 1958.

153. Werner, S. C.: Euthyroid Patients with Early Eye Signs of Graves' Disease: Their Responses to l-triiodothyronine and Thyrotropin, Am. J. Med. 18:608-612 (April) 1955.

154. Wiegand, H. R.: Anatomical and Technical Basis for Simultaneous Radiological Demonstration of Both Bony Optic Foramina, Klin. Monatsbl. Augenh. 131:452-487, 1957.

155. Wolter, J. R., and Jampel, R. S.: Formation of Retinal Folds Following Tumor Pressure on Bulbus, Klin. Monatsbl. Augenh. 131:433-438, 1957.

156. Yasargil, M. G.: Roentgen Diagnosis of Unilateral Exophthalmos, Report on 114 Cases, Bibl. ophth. (Supp.) 50:1-68, 1957.

157. Yudkin, A. M.: Congenital Anophthalmos in a Family of Albino Rats, Am. J. Ophth. 10: 341-345 (May) 1927.

158. Zetterström, B.: Exophthalmos: I. Symptoms and Diagnosis, Svenska läk. 54:3113-3115 (Oct. 18) 1957.

# Correspondence

## EVALUATION OF ABSORBABLE GELATIN FILM (GELFILM) IN CYCLODIALYSIS CLEFTS

*To the Editor:*—In the December, 1958, issue of the A. M. A. ARCHIVES OF OPHTHALMOLOGY, an article by Drs. Barsky and Schimek recounted the difficulties experienced by them with the use of Gelfilm in a cyclodialysis operation on rabbits. It is our impression that their technique and not the Gelfilm was responsible for the severe reactions that ensued in the rabbit eyes. We at the Mount Sinai Hospital in New York have done rabbit experiments, followed by operations on patients, as devised by one of us (J. Y.), placing Gelfilm through a scleral opening into the anterior chamber, the pupil first being made miotic. Our results have been uniformly good, and there has been no inflammatory reaction in the rabbit eyes and in the eyes of the patients operated on with this procedure. A complete report on our animal experiments and on our operations will be presented for publication soon.

JOSEPH LAVAL, M.D.
JULES YASUNA, M.D.
ROBERT COLES, M.D.
IRA ELIASOPH, M.D.
136 E. 64th St.
New York 21

*To the Editor:*—I would like to thank you for allowing me to answer Dr. Laval's letter.

It would seem that Dr. Laval has had better fortune in his results with Gelfilm, but before offering any rebuttal, I would like to read his article and evaluate his results.

Thus, for the present, I would like to reserve my opportunity to reply at a later date.

D. BARSKY, M.D.
100 Oak St.
Wyandotte, Mich.

# Obituaries

## WATSON GAILEY, M.D.
### 1882-1959

With the death of Watson Gailey, American Ophthalmology lost one of its most distinguished members.

Dr. Gailey was born in Ashland, Cass County, Ill., Sept. 7, 1882, and died Jan. 19, 1959, in Bloomington, Ill. He practiced there over fifty years, and his famous Eye Clinic brought fame to Bloomington and was known throughout the ophthalmological world.

Dr. Gailey came from a well-known family of physicians. His father and three brothers practiced medicine in Illinois. He graduated from the University

WATSON GAILEY, M.D.
1882-1959

of Illinois in 1904, served his internship at Cook Couny Hospital and a residency in the Illinois Eye and Ear Infirmary in 1905-1906. He settled in Bloomington in 1908.

For one-half a century he was active in national and international ophthalmological meetings and congresses. For fifteen years he was a member of the teaching staff of the American Academy of Ophthalmology. He was an active member in the American College of Surgeons, the Pan American Ophthalmological Society,

the Chicago Ophthalmological Society, and the Section on Ophthalmology of the American Medical Association.

He was a founder of the Central Illinois Society of Ophthalmology and Otolaryngology, and the first meeting was held in the Gailey Eye Clinic in 1945. In 1955, the tenth anniversary meeting was again held in Bloomington, and because of Dr. Gailey's personal prestige men of international fame from the four corners of the world attended and took an active part in this meeting.

Dr. Gailey did not stop with his great contribution as a physician and surgeon. In 1949, he established the Watson Gailey Eye Foundation, dedicated to the improvement of ophthalmology. This may prove to be his greatest monument, as the Foundation extends its work in granting scholarships and in continued development of the Eye Bank, which it created.

He is survived by his wife, Louise Huffaker Gailey; a daughter, Mrs. Charles D. Branch, of Peoria, Ill., and two grandsons, Watson Gailey Branch and Charles Digges Branch, Peoria, Ill. His unassuming kindness, his humor, his sterling character, and his professional skill and counsel will always be remembered by his many patients and friends.

RUDOLF AEBLI, M.D.

# News and Comment

## SOCIETY NEWS

**International Council of Ophthalmology.**—The International Council met in Paris on May 9, 1959. The following were present: Duke-Elder (President), Berens (Vice-President), Hartmann (Secretary), Streiff (Treasurer), Arruga, Espildora Luque, Lyle, MacDonald, Melanowski, Müller, Paufique, Uyemura, Weve, Bietti (International Organization Against Trachoma), Franceschetti (International Association for the Prevention of Blindness), François (European Society of Ophthalmology), Payne (Pan-American Association of Ophthalmology), Coppez (President of the last Congress), Sen (President of the next Congress).

The more important business concerned the following:

1. *Index Ophthalmologicus.*—In view of the expense it was decided not to publish the new edition for the International Congress in 1962 but to defer this until 1966.

2. *The XIX International Congress in Delhi.*—Dr. Keran Sen, proposed by the All-India Ophthalmological Society, was accepted as President-designate. The Congress itself will be held in New Delhi from Dec. 3-7, 1962. The full subscription for delegates will be 150 rupees (£10; $30 U. S.); for Associate Members the subscription will be one-third of this, and a 10% surcharge will be added to those who do not belong to a Society affiliated with the International Federation. Members of Council and Secretaries of the various Ophthalmological Societies affiliated with the Federation are asked to forward suggestions for the two major Discussions and four Symposia to the Secretary of the Council, Dr. Edward Hartmann (2 ave. Ingres, Paris), before May 1, 1960. The number of free papers will be limited to 50 which will be chosen from those offered by a committee of the International Council. The same committee will consider the films offered in order to eliminate those which are out of date, such as have been shown at previous congresses.

3. *Admission of New Societies.*—Three new ophthalmological societies were admitted to the Federation, the Section of Ophthalmology of the Society of Medical Sciences of Lisbon and the Ophthalmological Societies of Hong-Kong and Hungary.

4. *Standardization of Tonometers.*—A commission was set up to consider the advisability of the standardization of the X-tonometer and the applanation tonometer. The following have been invited to serve: Goldmann (Berne), Jackson (Edinburgh), Kronfeld (Chicago), Mahneke (Copenhagen), and Miller (Bonn).

5. *Standardization of Clinical Records.*—While the Council considered that it was not possible to suggest the standardization of clinical records which would be accepted by all countries, a commission was appointed to study the possibility of some standardization in records for glaucomatous patients and for patients who are traveling from one country to another. The following have been asked to serve: Berens (New York), Bietti (Rome), Franceschetti (Geneva), and Müller (Bonn).

The next meeting of the Council will be held at Athens on April 16, 1960, immediately prior to the opening of the first Congress of the European Society of Ophthalmology.

## ANNOUNCEMENTS

**Asia-Pacific Academy of Ophthalmology.**—The Asia-Pacific Academy of Ophthalmology will meet in Manila from Oct. 10 to 13, 1960. The principal subject of this meeting is Blinding Diseases in Asia. Under this heading, cataract, glaucoma, diseases of the cornea, trachoma, and nutritional deficiencies of the eye will be discussed.

In conjunction with the meeting in Manila, pre- and postconvention tours are planned to Japan and Hong Kong.

Ophthalmologists interested in presenting papers should contact Dr. William John Holmes, Secretary General, 1013 Bishop St., Honolulu 13, Hawaii.

Those interested in attending the meeting may obtain further information from Compass Travel Bureau, Inc., 55 W. 42d St., New York 36.

**Fight-For-Sight Fellowships.**—The National Council to Combat Blindness, Inc., announces that, upon the recommendation of its Scientific Advisory Committee, the closing date for receipt of completed applications for Fight For Sight full-time research fellowships, grants-in-aid, and summer student fellowships has been designated as Jan. 1, 1960. This change of date was found necessary in order to facilitate the processing of the increased number of applications being filed with the organization for review by the Committee. It will, in addition, make possible notification in early spring to those applicants for fulltime research fellowships where it has been established that this is essential. In such instances, the commencement date of the fellowship may be in advance of Aug. 1 but not prior to May 1.

In general, notification to applicants for full-time research fellowships and grants-in-aid will go forward in mid-July and the commencement date for awards will continue to be Aug. 1. Applicants for student fellowships will continue to be notified in mid-May of the action taken by the Scientific Advisory Committee in order that they may make arrangements with their respective institutions to commence work in early summer.

Appropriate forms may be obtained by addressing Secretary, National Council to Combat Blindness, Inc., 41 W. 57th St., New York 19.

The National Council to Combat Blindness, Inc., was founded in 1946 with the primary purpose of financing research in ophthalmology and related sciences. The objective of its program is the ultimate reduction of blinding eye diseases and ocular disorders through increased basic and clinical research in this field of scientific investigation.

From 1950-1958, the Council has allocated almost $750,000 for this purpose. Grants and fellowships approved at the May 31, 1959, meeting of the organization's Scientific Advisory Committee will be announced as soon as all official acceptances have been received.

**1959 Atlantic City Clinical Congress.—Ophthalmic Surgery Sessions.**—Wednesday, Sept. 30, 1:30 to 4:00 p. m., Joint Session: Pennsylvania Academy of Ophthalmology and Otolaryngology and the American College of Surgeons.

Co-Chairmen: Murray F. McCaslin, M.D., F.A.C.S., Pittsburgh, Past President of Pennsylvania Academy of Ophthalmology and Otolaryngology, and Harold G. Scheie, M.D., F.A.C.S., Philadelphia, Member of Advisory Council for Ophthalmic Surgery, American College of Surgeons.

Symposium on "Management of Glaucoma."

Moderator: Harold G. Scheie, M.D., F.A.C.S., Philadelphia.

1:30-1:50 "Present Status of Diamox in the Treatment of Glaucoma," by Goodwin M. Breinin, M.D., F.A.C.S., New York

1:50-2:30 "Value of Tonography in Glaucoma," by George S. Tyner, M.D., F.A.C.S., Denver

2:30-3:10 "Surgical Treatment of Glaucoma," by Joseph S. Haas, M.D., Chicago

3:10-3:30 "Present-Day Approaches of Research in Glaucoma," by Frank W. Newell, M.D., F.A.C.S., Chicago

3:30-4:00 Open discussion

Thursday, Oct. 1, 1:30 to 3:30 p. m., Joint Session: New Jersey Academy of Ophthalmology and Otolaryngology, Ophthalmology Section, and the American College of Surgeons.

Co-Chairmen: Louis A. Amdur, M.D., Jersey City, N. J., President of New Jersey Academy of Ophthalmology and Otolaryngology, Ophthalmology Section, and William B. Clark, Ophthalmology Section, and William B. Clark, M.D.,

F.A.C.S., New Orleans, Chairman of Advisory Council for Ophthalmic Surgery, American College of Surgeons.

Symposium on "Recent Advances in Ophthalmic Surgery."

Moderator: William B. Clark, M.D., F.A.C.S., New Orleans.

1:30-2:00 "Recent Advances in Cataract Extraction," by John M. McLean, M.D., F.A.C.S., New York

2:00-2:30 "Evaluation of Current Techniques in Retinal Detachment Surgery," by A. D. Ruedemann, M.D., F.A.C.S., Detroit

2:30-3:00 "Current Concepts in the Management of Malignancies of the Eye, Orbit, and Adnexa," by Algernon B. Reese, M.D., F.A.C.S., New York

3:00-3:30 "Present Status of Keratoplasty," by R. Townley Paton, M.D., F.A.C.S., New York

**Yale University School of Medicine Postgraduate Program in Ophthalmology, 1959-1960.**—Sept. 25: Dr. Graham Clark, "Personal Experiences with the Light Coagulator."

Oct. 9: Dr. Richard C. Troutman, "A Review of Experimental and Clinical Data Concerning Alpha-Chymotrypsin."

Oct. 23: Dr. George D. Pappas, "Electron Microscopy of the Ciliary Body and Its Relation to Aqueous Secretion."

Nov. 6: Dr. William Stone Jr., "Secondary Postenucleation Implants and Auxiliary Procedures."

Nov. 20: Dr. Dan M. Gordon, "Treatment of Uveitis."

Dec. 4: Dr. Fred Williams, "Interesting Cases in Eye Pathology."

Jan. 29: Dr. Norah duV. Tapley, "The Treatment of Retinoblastoma by X-Ray Alone and by the Combination of X-Ray and T. E. M."

Feb. 26: Dr. Carlton C. Phillips, "Subnormal Visual Aids."

March 11: Dr. H. Saul Sugar, "Secondary Glaucoma."

March 25: Dr. Harvey E. Thorpe, "The Management of Intraocular Foreign Bodies."

Each of these meetings is held in the Beaumont Room, Sterling Hall of Medicine, 333 Cedar St., New Haven, Conn., on a Friday at 3:45 p. m.

# Books

**Geographic Ophthalmology.** Edited by William John Holmes, M.D. Price, $8.50. Pp. 293, including index, with numerous illustrations. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Ill., 1959.

This book consists of a collection of articles on tropical ophthalmology by different authors, edited by Dr. Holmes. It is not an inclusive text on all the major eye diseases that occur in Africa, Asia, and Australia, but a few diseases have been singled out and dealt with in detail. The lead article, by Dr. Alvaro, covers the progress of ophthalmology throughout the world for the past 100 years. Another chapter is devoted to blindness and the prevention of blindness in India. A very excellent account of leprosy of the eye was written by the editor. Trachoma, onchocerciasis, phlyctenulosis, xerophthalmia, keratomalacia, and pterygium are well documented. There are special sections devoted to unusual subjects such as westernizing the Oriental eye, the Smith Indian cataract extraction, and cataract surgery as an office procedure.

The book contains much of interest not only for ophthalmologists daily encountering these problems but for general reference.

**Les Cataractes congénitales.** By Jules François. Price, 11,000 fr. Pp. 850, with 486 illustrations and 20 color plates. Masson & Cie., 120 boulevard Saint-Germain, Paris 6°, 1959.

This beautifully illustrated text encompasses all that is known about congenital cataracts. It is comparable in its scope to the old German "Handbuch," or handbook, and is to be used as a reference work.

The book starts with a survey of the embryology and anatomy of the lens. This is followed by a very complete documentation of all forms of congenital cataract, both with and without congenital lesions in the body, including the many so-called syndromes. Various causes of congenital cataract, such as viruses, toxic and endocrinologic factors, and radiation cataract, are given consideration.

The treatment of congenital cataract is considered, and such important questions as when to operate and what type of procedure to use are well discussed. François writes in a very clear and easy style, so that anyone with a smattering of French should have no trouble reading it. There is an excellent bibliography at the end of each chapter.

This is another monumental work of great value to ophthalmologists, and both the author and the French Ophthalmological Society, which sponsors the book, deserve our thanks.

**Ophtalmologie: Directives thérapeutiques médico-chirurgicales.** By G. Offret and G. Lombard. Price, not given. Pp. 369. Gaston Doin & Cie, 8 place de l'Odéon, Paris 6°, 1959.

The first part of this book suggests the treatment of various symptoms complained of by the patient, for example, tearing, photophobia, diplopia, poor vision, difficulties in adaptation, and visual fatigue. This is an unusual approach but interesting. The second part deals with the pharmacology and pharmacodynamics of drugs used in the eyes or used generally in eye diseases. The third deals with treatment for various ocular diseases, apparently selected somewhat at random. The fourth and fifth sections deal with treatment of general diseases affecting the eyes and with ocular tumors.

The book is written in readable French and has a fairly complete index.

**Treatment of Cancer and Allied Diseases: Vol. III. Tumors of the Head and Neck.** By George Pack and Irving Ariel. Price, $30. Pp. 781, including index, with 1028 illustrations. Paul B. Hoeber Inc. (medical book department of Harper & Brothers) 49 E. 33d St., New York 16, 1959.

Ophthalmologists will be interested in this book for the two chapters on tumors of the eyelids and orbits, by Cecil O'Brien, treatment of tumors of the eye, by Ira S. Jones. There is a chapter on methods for relief of pain in cancer of the face and neck, by Francis Grant, which also has ophthalmological application. The second edition, however, varies very little from the previous edition, and the bibliography quoted in the section on lid and orbital tumors contains nothing beyond 1948. The section on treatment, however, does contain more recent references and particularly the treatment of retinoblastoma by radiation and triethylenemelamine.

**Yearbook of Ophthalmology (1958-1959 Series).** Edited by Derrick Vail, M.D. Price, $7.50. Pp. 407 pages, including index, with 78 illustrations. The Year Book Publishers, Inc., 200 E. Illinois St., Chicago 11, 1959.

This excellent practical résumé of the year's literature in ophthalmology is similar to the previous editions edited by Derrick Vail. It contains a special article on recent advances in diagnosis and medical therapy of chronic simple glaucoma, by Bernard Becker. The literature is covered by an anatomical classification, with added chapters on neurology and visual fields, glaucoma, therapy, surgery, and a short collection of miscellaneous subjects. The added advantage of this series of abstracts are the illustrations, which are plentiful, and the editorial comment, which always reflects good common sense and judgment.

**The Use of Drugs in Refraction.** By D. W. A. Mitchell. Second edition. Price, $4.50. Pp. 146, including index. British Optical Association, 65 Brook St., London W. 1, 1959.

This book was written primarily to provide ophthalmic opticians with information for the use of drugs in their work. Since no one in this country except those holding the degree of M.D. can use drugs in the eyes, it is evident that the book is written from a fairly elementary standpoint and will have little interest for this practicing ophthalmologist.

The first chapter is devoted to the anatomy and physiology of the eye; the rest is largely concerned with the pharmacological action of drugs, their methods of instillation, and chapters on prescription writing. The book might be useful for nurses and medical students.

**Textbook of Medicine.** Edited by Russell L. Cecil and Robert F. Loeb. Tenth edition. Price, $16.50. Pp. 1665, with 89 pp. index and 132 figures. W. B. Saunders Company, 218 W. Washington Sq., Philadelphia 5, 1959.

The tenth edition of this well-known text on general medicine contains a number of new articles not previously covered in the other editions. Of interest to ophthalmologists are pharyngoconjunctival fever, cranial arteritis, cryoglobinemia, and Marfan's syndrome. The articles, by outstanding authors in the various fields, are clear and concise, and the text in every way is useful as a reference book for ophthalmological libraries.

**Hypertension: The First Hahnemann Symposium on Hypertensive Disease.** Edited by John H. Moyer, M.D. Price, $14. Pp. 790, with illustrations. W. B. Saunders Company, 218 W. Washington Sq., Philadelphia 5, 1959.

A symposium on hypertension was held at Hahnemann Medical College in December, 1958. Many of the outstanding experts in hypertension took part in this conference, and this book contains the published papers with the discussions.

For anyone interested in hypertension, the book is valuable. Only two chapters relate directly to the eye: these are "Retinovascular Changes in Hypertension," by Albert Brust, and "The Effect of Blood Pressure Reduction on Vascular Changes in the Eye," by Walter Kirkendahl and Mark Armstrong. It should be in every ophthalmological library as a reference work on the present status of the hypertensive patient.

**Glaucoma: Transactions of the Third Conference, Jan. 8, 9, and 10, 1959.** Edited by Frank W. Newell, M.D. Price, $5.25. Pp. 272, including index, with 73 figures. Josiah Macy Jr. Foundation, 16 W. 46th St., New York 36, 1959.

The papers presented at the Third Conference on Glaucoma by this group of experts together with the complete discussions which ensued, follows the general pattern of the previous two conferences and is extremely valuable for all ophthalmologists who wish to keep abreast of the current thinking in this perplexing subject. This volume is especially practical, containing a chapter on tonography, by W. Morton Grant, and "Tonography in the Clinical Management of Glaucoma," by Winston Roberts. The other two chapters are largely theoretical: a discussion of the osmotic factors in the formation of aqueous humor, by Barany, leads to the conclusion that the osmotic forces between aqueous humor and plasma cannot account for the transport of water into the eye and are relatively unimportant. This leaves unanswered the question of what moves water into the eye across the ciliary epithelium. An interesting chapter, by Perkins, on consensual changes in intraocular pressure under experimental conditions describes the changes in pressure which occur in the second eye when tonometry and tonography is done on the other.

It is to be hoped that these conferences will continue. At times they seem to be productive of almost complete annihilation of the conclusions reached in the last ten years, and there is no question that they have been instrumental in pointing out serious fallacies in reported work which has been generally accepted. This is as it should be, however, and it is far better to have the house torn down and start again than to go on building on insecure foundations.

Needless to say, the contributions by the discussors are of equal importance with the papers presented. Those participants who are members of the Conference are as follows:

Peter C. Kronfeld
Frank W. Newell
Elmer J. Ballintine
Bernard Becker
Robert W. Berliner
Russell L. Carpenter
Paul A. Chandler
Melvin L. Goldman
W. Morton Grant
David O. Harrington
V. Everett Kinsey
Thomas H. Maren
Herbert S. Ripley
Winston Roberts
Harold G. Scheie
Robert N. Shaffer
George K. Smelser
H. Saul Sugar
Ludwig J. K. von Sallman
Lorenz E. Zimmerman

The following guests were present:

Ernst H. Barany
Frank J. Macri
William K. McEwen
Edward S. Perkins

**The Preservation of Eyesight.** By Sir Arthur Salusbury MacNalty. Price, $3. Pp. 107, including index. Williams & Wilkins Company, Mt. Royal & Guilford Aves., Baltimore 2, 1959.

This book was prepared by a consultative Committee on the Preservation of Eyesight to explain in nontechnical language how the eyes may be protected, how misuse may be prevented, and what the ordinary diseases are which affect mankind. It is directed to the lay public and contains information regarding the structure and the function of the eye. A chapter on lighting and eyesight is useful for ophthalmologists. The common affections of the eye are listed; the methods of prevention of diseases and injuries of the eye in industry, methods

for testing eyes and the prescribing of spectacles, and information on the eye in old age and blindness are included.

The value of any book of this character rests on the selection of material. The majority of subjects given space here represent information which the public should have, but there are far too many pages taken up with rare conditions which are hardly ever seen even by experienced physicians, such as descriptions of lead poisoning, poisoning by benzene derivatives and carbon bisulfide, and miners' nystagmus. These hardly warrant space in a book of this kind.

A few generalized statements will not be agreed to by most of us in this country. Examples are that senile cataract is "commonly seen after the age of 45 or 50 years"; also that the most frequent causes of blindness in adult life are myopia, diabetes, and trauma. On the whole, the book has much of common sense and fulfills its purpose.

# when the eyes have it

There are five dosage forms of Neo-Synephrine hydrochloride especially formulated for vasoconstriction and mydriasis in ophthalmologic conditions.

**½% solution**

Decongestant collyrium for rapid relief of burning, itching and smarting.

**2.5% solution**

For short acting mydriasis in refraction, ophthalmoscopy, surgery and the treatment of glaucoma.

**10% solution (plain or viscous) and emulsion**

In uveitis: With atropine, for freeing recently formed posterior synechiae and preventing their formation.

In glaucoma: For temporarily reducing intra-ocular tension and for performing the provocative test for angle block.

For use in surgery.

*Available in convenient Mono-Drop* squeeze bottles that eliminate dropper contamination and simplify instillation.*

# NEO-SYNEPHRINE®
Hydrochloride

## wide application in ophthalmology

Winthrop LABORATORIES • NEW YORK 18, N. Y.

*Mono-Drop, trademark

Neo-Synephrine (brand of phenylephrine), trademark reg. U.S. Pat. Off.

# FOR POTENT MIOSIS

*. . . in chronic non-congestive glaucoma*

# CARBAMIOTIN

CARBACHOL U. S. P.

*Iso-Sol brand of sterile, dated, low surface tension solution of Carbamylcholine Chloride with Benzalkonium Chloride 1:10,000 as the wetting agent.*

**¾% and 1½%**

**ADVANTAGES**

Acts indirectly by inhibiting cholinesterase and permits natural acetylcholine to act without interference . . . not susceptible to destruction by cholinesterase . . . low allergic index . . . prolonged use will not produce synechia . . . lasts longer — less frequent administration . . .

**INDICATIONS**

For reduction of intraocular tension in chronic, non-congestive glaucoma . . . can replace pilocarpine or eserine in manifestations of allergy, sensitization or lack of response to these drugs . . .

**PACKAGING**

In 15cc. sterile sealed Lacrivials® ¾% and 1½%

*For samples, literature and bibliography, write . . .*

ISO-SOL®

**THE ISO-SOL COMPANY, INC.**
**LINDENHURST, N. Y.**

*Pioneer Specialists in Sterile Ophthalmic Solutions*

*provide protection for your athlete-patients*

**with the ALL-NEW**

# ALL AMERICAN®

## ATHLETIC GLASSES

NOW! Reinforced ends for rough use
Expandable, adjustable "Glass Gard" headband
"Cushion Fit" shock absorbent rubber nose piece
Special contoured lenses to fit face
Extra deep eye-wire channel to hold lenses securely
Drop-ball tested safety glass or plastic lenses

**ALL-NEW SAFETY DESIGN!**

• ALL AMERICAN ATHLETIC GLASSES are a wise investment in eye safety for athletes. These all-new glasses have been designed by BENSON to provide the finest in protection without interfering with performance . . . *assuring complete player confidence!* Note the specific design features above — and you'll agree that your athlete-patients who wear glasses deserve this kind of all-around protection.

**Advertisements reaching thousands of athletic coaches and athletes around the country will advise *"Order through your doctor."* Be ready — examine a complete sample at nominal cost. *Write today . . .***

**SIZES**

44-20
44-23
47-20
47-23

Temples available from 6" through 7" cable.

BENSON OPTICAL COMPANY

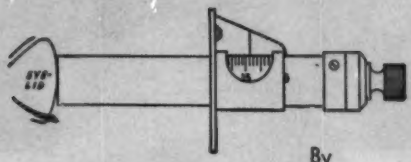
Executive Offices • 1812 Park Avenue, Minneapolis

specialists in prescription optics since 1913

COMPLETE LABORATORIES CONVENIENTLY LOCATED IN UPPER MIDWEST CITIES

*—For Green's Refractor—To Measure Vertex Distance*

# Phoro-Lenscorometer



By
(Austin Belgard)

To measure vertex distance, just clear instrument of lenses, place Phoro-Lenscorometer through opening, making contact with patient's closed lid—and read direct. No computing necessary.

**$18.00**

Austin Belgard

**OPHTHALMIC OPTICIANS—Wholesale Rx Service**

**Main Office** **109 N. Wabash, at Washington** **Box "O", Chicago**

## *For the Extra Refracting or Treatment Room*

**CHAIR:** Upholstered, reclining, adjustable headrest, can be raised or lowered by large ball-bearing wheel; can be locked in any position; elevation 18 to 24". $155.00 in brown, green or black. Other colors available at $5.00 extra.

**CABINET:** Stainless steel covered; wall mounted or floor model; with or without electrical equipment. Can be furnished with pull-out writing shelf and horizontal drawers on roller bearings. $115.00 to $290.00

**STOOL:** Upholstered; with or without backrest; ballbearing casters. $20.00—$26.00 in brown, green or black. Other colors available at $1.00 extra.

**LIGHT:** Can be mounted on Chair or wall; vertical movement by means of self-adjusting clutch on bar, lateral and anterior-posterior movement by means of goose-neck. $22.00

**LIGHT SHIELD:** For standard 100 watt lamp $5.00

**STAINLESS STEEL TISSUE CONTAINER:** $3.00

1905 Beverly Blvd. SMR Los Angeles 57, Calif.

**Established over 30 years**

*CATALOGUE ON REQUEST*

new

# OPHTHOCORT® IN EYE INFECTIONS

## WIDE ANTIBACTERIAL SPECTRUM

## UNSURPASSED THERAPEUTIC EFFICACY

**CHLOROMYCETIN provides effective wide-spectrum therapy** "...is effective against most gram-positive and gram-negative cocci and some gram-negative bacilli. It rarely produces dermatitis and resistant strains are uncommon."[1]

**POLYMYXIN B controls gram-negative organisms** "...gram-negative bacilli are being isolated with increasing frequency from the conjunctiva..."[2] Polymyxin B "...is bactericidal against most gram-negative microorganisms..."[3]

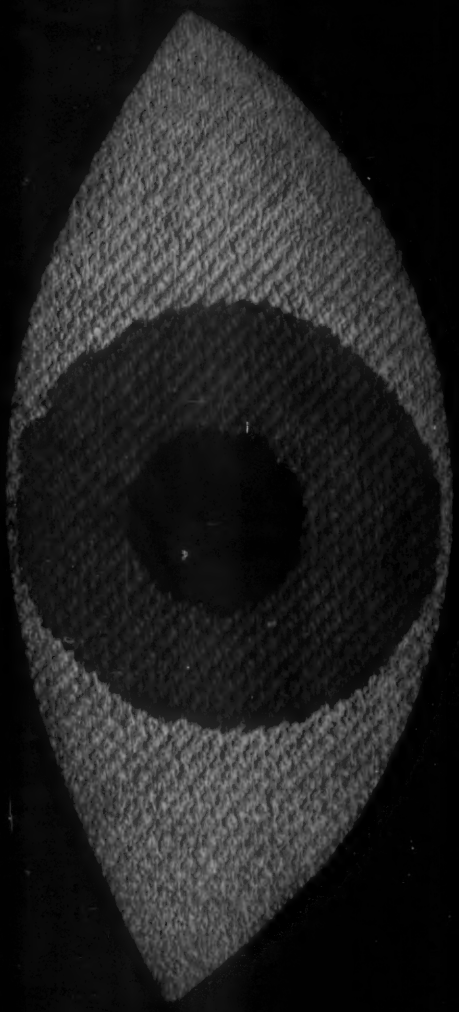
**HYDROCORTISONE controls inflammation and allergic reactions** "Cortisone, hydrocortisone and ACTH, by altering the inflammatory responses of the body, cause a decreased amount of scarring and vascularization."[4] "Hydrocortisone is about twice as potent gram for gram as cortisone, even when given locally."[4]

**Indications:** Provides wide-spectrum antibacterial, anti-inflammatory, and antiallergic action for topical treatment of patients with ocular inflammation complicated by infection.

**Administration:** Local application two to four times daily as required.

**Packaging:** OPHTHOCORT Ophthalmic Ointment contains 1% CHLOROMYCETIN® (chloramphenicol, Parke-Davis), 0.5% hydrocortisone acetate, and 5,000 units polymyxin B-sulfate per Gm., supplied in ⅛-oz. tubes.

**References:** (1) Perkins, E. S. **Practitioner 178**:575, 1957. (2) Smith, C. H. **Eye, Ear, Nose & Throat Month.** 34:580, 1955. (3) Blakiston's New Gould Medical Dictionary, ed. 2. New York, McGraw-Hill Book Company, Inc., 1956, p. 945. (4) Osler, H. B. & Braley, A. E. **J. Iowa M. Soc.** 44:427, 1954.



PARKE, DAVIS & COMPANY

# Eyes Made To Order

Walter Melcher is applying color on an artificial eye. He needs the skill of an expert glass blower plus the coloring technique of an artist to match eyes of all shapes and colorings. Fortunately, Walter is heir to 105 years' experience. Our skilled glass and plastic eyemakers have passed along and perfected their technics since 1851. These men visit most areas regularly to make artificial eyes that are perfectly matched for your patients—another reason to call or write our nearest office on your next replacement.

**Complete Artificial Eye Service**

- Eyes custom made—glass or plastic
- Eyes from stock sent on same day order received—glass or plastic
- Damaged or broken eyes accurately matched
- Fitted to all types of motility implants
- Implants, X-Ray therapy shields, foreign body locators
- Superior Quality—Finest Workmanship

**Mager and Gougelman Inc.**

Serving the Profession Since 1851

30 N. Michigan Ave. Chicago 2, Illinois

120 E. 56th St. New York 22, N. Y

CLEVELAND DETROIT HOUSTON (Soper Bros.)
KANSAS CITY MINNEAPOLIS ST. LOUIS
BOSTON PHILADELPHIA PITTSBURGH WASHINGTON

## URGENT REQUEST

The Uveitis Laboratory, University of California School of Medicine, San Francisco, is interested to obtain freshly enucleated eyes from patients with *all types of uveitis* and other endogenous inflammations. Attempts are being made to isolate etiologic agents from these eyes.

The eyes should *not* be fixed in preservatives or frozen, but placed in a sterile bottle, packaged, and shipped as quickly as possible. Please send specimens air express, special delivery, *collect*. Enclose history and findings and mark the package "Fresh Tissue Specimen—Rush."

A report of isolations of organisms and pathologic findings, including a slide, will be sent to the contributor. Credit will be given in any resulting publications if desired.

*Telegraph collect if specimen being sent.*

Send eyes to

Samuel Kimura, M.D., Michael J. Hogan, M.D., or
Phillips Thygeson, M.D.

University of California School of Medicine

San Francisco 22

*WHEN YOUR DIAGNOSIS INDICATES*

**ORTHOPTICS**

*CONSIDER OUR SALES RECORD OF OVER 11,000 SETS OF*

**DVORINE ANIMATED FUSION CHARTS**

A complete set of fusion charts in full color for office and home training, Base-in and Base-out.

*OUTSTANDING FEATURES*

- Animation
- Gay Colors
- Duo-Chrome Spectacles and Drawing Outfit
- Nine Groups of Charts
- Vertical Fusion Device
- Tracing Sheets

ALL IN ONE SET
*with directions*
**$12.00**
Less 5% if check accompanies your order

Available on prescription at your Ophthalmic Dispenser, American Optical Co., and other optical supply houses.

**SCIENTIFIC PUBLISHING CO.**
Dept. A—2328 Eutaw Place Baltimore 17, Maryland

# 3 ophthalmic products with distinctive advantages...

- their wide-spectrum bactericidal activity includes *ALL clinically isolated strains of Pseudomonas aeruginosa*, a serious invader noted for the rapidity of its destructive powers.
- their component antibiotics rarely sensitize.

## 'NEOSPORIN'®

brand Polymyxin B-Gramicidin-Neomycin

### ANTIBIOTIC OPHTHALMIC SOLUTION

Available in bottles of 10 cc. with sterile dropper.

## 'NEOSPORIN'®

brand Polymyxin B-Bacitracin-Neomycin

### ANTIBIOTIC OINTMENT

Available in ⅛ oz. ophthalmic tubes.

## 'CORTISPORIN'®

brand Polymyxin B-Bacitracin-Neomycin with 1% Hydrocortisone

### ANTIBIOTIC OINTMENT

Available in ⅛ oz. ophthalmic tubes.

**BURROUGHS WELLCOME & CO. (U.S.A.) INC., Tuckahoe, New York**

Absolute sterility of all surfaces of the Minims unit is assured by the pliofilm over-wrap.

Minims units for each drug contain the quantity sufficient for usual administration of that particular drug.

# MINIMS®

## STERILE OPHTHALMIC DROPS IN DISPOSABLE UNITS

Minims solutions remain stable for an indefinite period.

Available in packages of 20 individually over-wrapped Minims.

•

*For further information or literature write or phone:*

Ophthalmic drugs available in the Minims package:

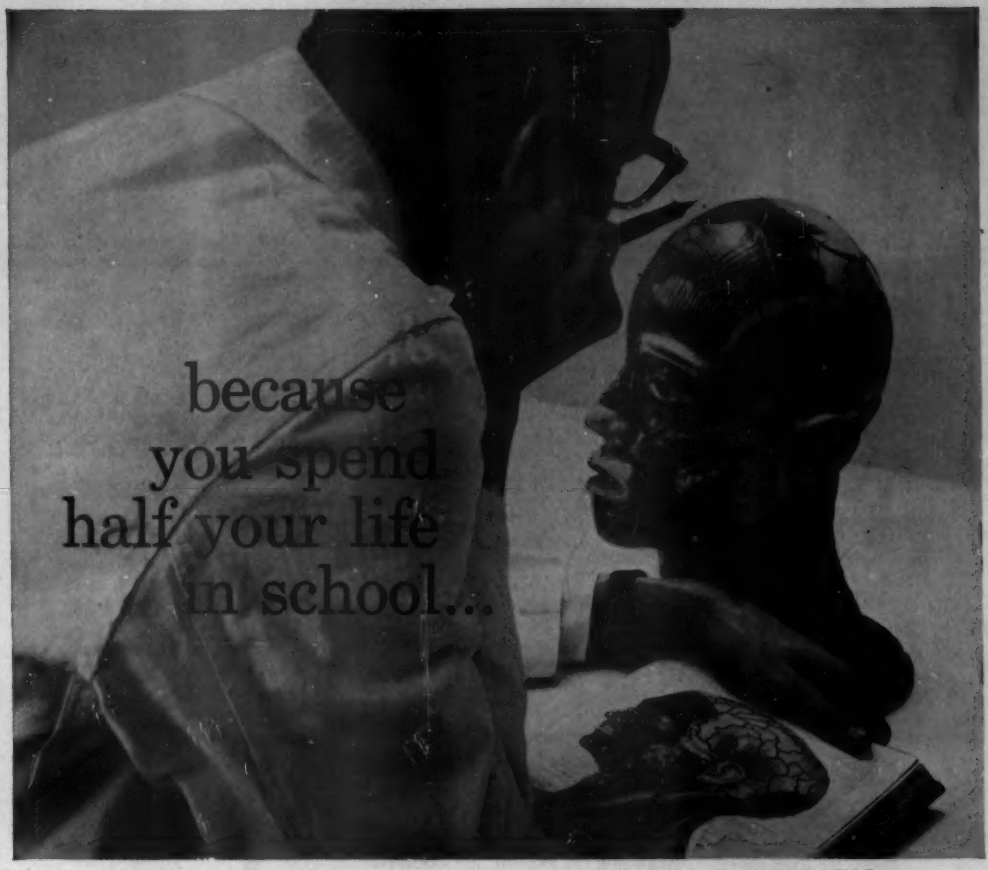
- ATROPINE SULFATE 1%
- ATROPINE SULFATE 2%
- ESERINE SALICYLATE 0.5%
- ESERINE SALICYLATE 0.25%
- PILOCARPINE HCl 1%
- PILOCARPINE HCl 2%
- FLUORESCEIN SODIUM 2%
- HOMATROPINE HBr 2%
- HOMATROPINE HBr 5%
- PHENYLEPHRINE HCl 2.5%
- PHENYLEPHRINE HCl 10%
- SCOPOLAMINE HBr 0.2%
- TETRACAINE HCl 0.5%

MINIMS...a particularly valuable administration unit for...

- SURGERY
- OPHTHALMOLOGICAL OFFICES
- HOSPITAL WARDS
- INDUSTRIAL MEDICINE
- EMERGENCY ROOMS
- PATIENT USE

Barnes-Hind

895 KIFER ROAD
SUNNYVALE, CALIF.
REgent 6-5462




## *you need the protection of* TRUE SECURITY

You probably spend about four more *years* and nine thousand more *dollars* for your education than the average man. This delay and possible debt can be major financial handicaps during your early years in practice.

But even if you have been practicing for many years, you very likely are constantly harassed by other financial problems peculiar to your profession—an income pattern that is different from the ordinary, continual investment in costly equipment, a probable lack of "fringe" benefits for retirement and many others.

More than a century of close association with medical men has given Mutual Benefit Life a thorough comprehension of these problems. Mutual Benefit Life can help you meet your particular needs with an exclusive plan for TRUE SECURITY—a practical, economical program to give you and your family complete financial protection.

Your Mutual Benefit Life man is a specialist in financial planning for the medical man, and his advice is yours without obligation. Why not get in touch with him soon.

**MUTUAL BENEFIT**
*The* **LIFE** *Insurance Company for TRUE SECURITY*

## MUTUAL BENEFIT LIFE'S FINANCIAL PLANNING FOR YOU AND YOUR FAMILY

*Send this coupon for your free copy of an analysis of the medical profession's financial problems and their solution.* This is not only an insurance booklet *but an overall handbook showing how you can keep more of your earnings. The use of this coupon does not obligate you in any way.*

THE MUTUAL BENEFIT LIFE INSURANCE COMPANY
AGENCY DEPT. AO-1
NEWARK 1, NEW JERSEY

Name.....

Address.....

City.....State.....

an important problem in today's living...

The following articles from TODAY'S HEALTH are now available in pamphlet form.

**ALCOHOLISM IS A DISEASE.** A discussion by the Chairman of the A.M.A. Committee on Alcoholism. by Marvin A. Block, M.D., 8 pages, 15 cents.

**I AM THE WIDOW OF AN ALCOHOLIC.** Three articles combined. by Virginia Conroy, 16 pages, 20 cents.

**HOW EXPERTS MEASURE DRUNKENNESS.** A partial transcript of an actual courtroom case. by H. A. Heise, 8 pages, 15 cents.

**BARBITURATES, BOOZE AND OBITUARIES.** A discussion of the dangers of mixing alcohol and barbiturates. by Donald A. Dukelow, 4 pages, 10 cents.

**TWELVE STEPS FOR ALCOHOLICS.** A frank discussion of the meaning of an alcoholic behavior. by Richard Lake, 6 pages, 10 cents.

**These articles are available in one pamphlet for 50c**

**ALCOHOLICS ANONYMOUS.** Written from the standpoint of a member, the basic treatment procedures are described and the psychological problems confronting the alcoholic are discussed.

**ALCOHOL AND CIRRHOSIS OF THE LIVER.** Relationship between alcohol, diet and cirrhosis. Increasing stress on nutritional differences. by Russell S. Boles.

**HOW TO HELP A PROBLEM DRINKER.** Understanding the alcoholic's capabilities, the necessity of help, causes of his condition. by Edward A. Strecker and Francis T. Chambers, Jr.

**THE TREATMENT OF ALCOHOLISM.** Tracing the steps from convincing the alcoholic that he is sick through treatment and cure. by Lewis Inman Sharp.

**CONDITIONED REFLEX TREATMENT OF CHRONIC ALCOHOLISM.** Its place among methods of treatment today, its development and correlation with personality factors. by Walter L. Voegtlin.

**INSTITUTIONAL FACILITIES FOR THE TREATMENT OF ALCOHOLISM.** Comparative differences, in drinking, with the last century, new establishments and methods of treatment, lack of trained personnel. by E. H. L. Corwin.

ADDRESS REQUESTS TO

ORDER DEPARTMENT

AMERICAN MEDICAL ASSOCIATION

535 N. DEARBORN ST., CHICAGO 10, ILLINOIS

storz
Surgical Instruments

# Electro-Keratotome

## CASTROVIEJO

*For the Dissection of Lamellar Grafts.*

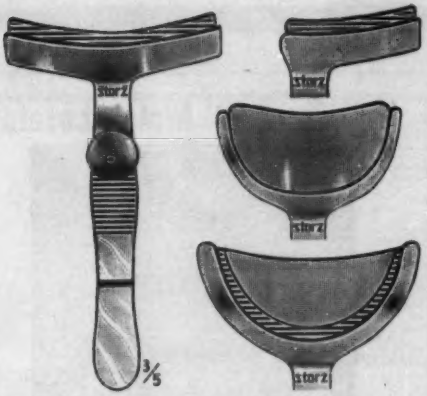
**Procedure is shortened, and minimally traumatized grafts of even thickness and as large as permitted by the donor's eye are obtained, a result difficult to achieve by older methods, especially with larger grafts.**

- **Small enough to observe the donor eye for which it is used only.**
- **Edge of cutting blade visible through open roller guards, enabling surgeon to start and complete graft at exact margins. Uses small, disposable, double-edged razor blade. Simple mechanism.**
- **Shims are provided in thickness of 0.1, 0.2, 0.3, 0.4 and 0.5 mm., permitting grafts from 0.1 to 0.5 mm. thick. This method so accurately controls the thickness that two grafts of 6 mm. diameter have been removed from a single donor eye.**

**INSTRUMENT ALSO USEFUL FOR cutting buccal mucous grafts for plastic repair in cases of symblepharon or extensive scarring of the conjunctiva. The mucous membrane can be taken from the buccal surface of lip or cheek. It cuts the grafts so thin that they need no further thinning, which was impossible with previous instruments.**

**Head of instrument is Stainless Steel. Motor is rotary type, AC or DC, 110 V.**

*Ref., Am. Journal Ophth., Feb. 1939*




**CLAMPS**

**E-2961 through E-2965 are used with E-2950 Electro-Keratotome for cutting of buccal mucous grafts.**

**Prices upon Request.**

**E-2950** Electro-Keratotome, CASTROVIEJO: with one dozen blades, footswitch and Norelco motor... **$176.00**

**E-2952** Extra Blades for **E-2950** per doz. ...**$1.50**

- **CLAMPS**

**E-2961** Clamp, Lip, CASTROVIEJO: "T" shape
**E-2962** Clamp, Lip, CASTROVIEJO: right
**E-2963** Clamp, Lip, CASTROVIEJO: left
**E-2964** Clamp, Cheek, CASTROVIEJO: small
**E-2965** Clamp, Lip, CASTROVIEJO: large

*Storz Instrument Company*

**4570 Audubon Avenue** **ST. LOUIS 10, MISSOURI**

*New York Showroom:* 157 E. 64th St.—at Lexington Ave.

# Looking?

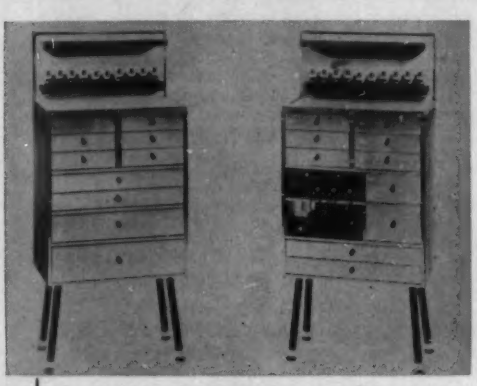
## FOR CONTACT LENSES OF THE HIGHEST QUALITY?

1. OBRIG LABORATORIES is the pioneer and oldest manufacturer of plastic contact lenses.
2. OBRIG LENSES are the product of twenty years of research and experience.
3. OBRIG LENSES stand for unsurpassed quality and excellent service.
4. OBRIG LABORATORIES makes available to its customers a consultation service and assists them with their problem fitting cases.
5. OBRIG LABORATORIES keeps its fitters abreast of all the latest developments and techniques in the contact lens field.

**Obrig LABORATORIES, INC.**
Manufacturers of all types of *contact lenses*

*new york office* . . .
75 East 55th Street
New York 22, N. Y.

*sarasota, florida office* . . .
P. O. Box 791
Sarasota, Florida



**STAINLESS STEEL CABINETS**
**FOR THE OPHTHALMOLOGIST**
**AND THE OTOLARYNGOLOGIST**

Formica covered working surface. Other models start at $60.00. Stools and instrument tables available.

**P & S MEDICAL EQUIPMENT**
14525 Arminta, Van Nuys, California
ST 0-0447

## The Berman Metal Locator

An electromagnetic detecting device that quickly and accurately locates metallic foreign bodies, including magnetic intraocular foreign bodies. Metallic fragments are readily detected from a satisfactory distance through intervening bone, tissue and fluids. Probing or physical contact with the foreign body is not required for detection.

The thin sterilizable probe provides preoperative localization, "pin-point" accuracy within the incision and postoperative check.

Lends precision to foreign body surgery and greatly reduces surgical trauma.

**BERMAN LABORATORIES**
112-03 Rockaway Blvd. Ozone Park 20, N. Y.

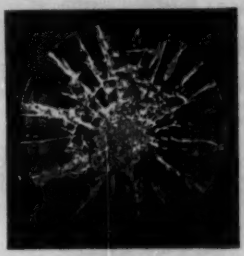
MOTEX
T. M. REG. U.S. PAT. OFF.

LAMINATED SAFETY LENSES

*With 25 years of Safety Experience . . .*

. . . add safety to any ophthalmic correction. Everyone who wears glasses is entitled to know that his correction can be supplied in *Motex Construction*. This applies especially to *wearers of minus corrections* who are not aware of the hazards their thin-center lenses represent.

*Motex are warranted to give satisfactory service for the life of the correction. Warranty slips are supplied with each pair of genuine Motex lenses.*



OPTICAL INDUSTRIES
INCORPORATED
1701 GENT AVENUE
INDIANAPOLIS 2, INDIANA

announcing

ARMORGREY

***Armorlites are now available in uniform density neutral grey***

Armorgrey Medium
Armorgrey Dark
/
Single Vision
or
Bifocal

*distributorship inquiries invited*

ARMORLITE LENS co., inc.
the developers of hard plastic lenses
117 EAST COLORADO ST • PASADENA, CALIFORNIA

Shown is S438
Lens 3¼" x 2½", 6.50 D.

**i-gard** *precision* **MAGNIFIERS**

Judge them from any standpoint and you'll agree that I-Gard magnifiers are in a class by themselves.

**Accurate magnification** for eye comfort is unsurpassed . . . assured in most types by *Aspherical* lenses covering the widest possible field of view, with perfect distortion-free vision from edge to edge. The remarkable I-Gard plastic lenses also have high resistance to breakage.

**Comfortable, steady handling** results from amazingly light weight, perfection of balance and grip design.

**Perfect gifts** . . . handsomely mounted on ivory-tinted frames. *Get full information* from your I-Gard distributor, or write us.

**24 MODELS . . . HAND, STAND, FOLDING . . . VARIOUS SIZES AND POWERS**

S1000 Folding 1⅜" x 1¼", 9 D.

S422 Hand Strip Cross Cylinder 3½" x 1½", 4 x 10 D.

S442 Hand Reader 4" x 3", 8 D.

S428 Cataract Stand Reader 50 mm. dia., 20 D.

Stand Readers 4 Sizes . . . Monarch shown 6½" x 4⅛" lens 4.50 D.

**McLEOD** *Optical Company, Inc.* 357 Westminster Street, Providence 1, Rhode Island


## NEW ORLEANS ACADEMY OF OPHTHALMOLOGY

The Tenth Annual Meeting of the New Orleans Academy of Ophthalmology will be held in the International Room, Roosevelt Hotel, 123 Baronne Street, New Orleans, February 8-12, 1960.

### SYMPOSIUM

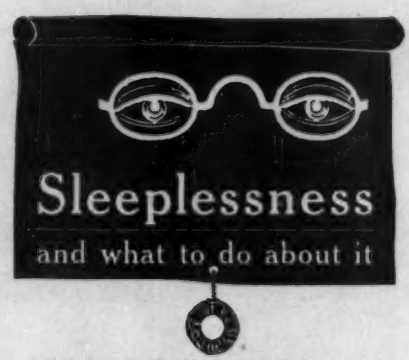
"LIDS, CONJUNCTIVA AND CORNEA"

### PANEL

Ray Berke, M.D. — Townley Paton, M.D.
Phinizy Calhoun, Jr., M.D. — Byron Smith, M.D.
Ramon Castroviejo, M.D. — Phillips Thygeson, M.D.
Lorenz Zimmerman, M.D.

The registration fee of $75.00 includes associate membership in the Academy for the year of 1960, as well as all other features of the convention. Hotel reservations should be made early by writing directly to the

**EXECUTIVE SECRETARY, P.O. BOX 469, NEW ORLEANS, LA.**


**SO YOU CAN'T SLEEP?**
by P. H. Fluck
8 pages, 15 cents

**SLEEPLESSNESS AND WHAT TO DO ABOUT IT** by Donald A. Laird, Ph.D.
8 pages, 15 cents

**ROADS TO RELAXATION**
by Joseph L. Fetterman, M.D.
4 pages, 10 cents

**AMERICAN MEDICAL ASSOCIATION**
535 N. Dearborn St., Chicago 10, Illinois

# A FRANKLIN "DREAM" *Perfected*

## THE NEW KUROVA M ONEPIECE, STRAIGHT-LINE BIFOCAL!

Everybody knows about the original Franklin bifocal—crude, but functional! And everybody deserves to know about the Kurova M straight-line, one-piece bifocal—perfected and doubly effective!

To begin with, the Kurova M is a true "no-jump" bifocal, since the reading geometric center is deliberately located at the segment top. Furthermore, M has a full-sweep reading area with possibilities for insets. All these features make M an excellent lens for new wearers; fine for the wide reading field requirements of regular wearers . . . in fact, a good all-purpose lens.

Think of Kurova M when you think of a near-perfect bifocal. It's a first quality lens by Continental.

*Blank size:* 55 x 60 m/m. Finished reading field may be set from 12½ to 27½ m/m high.

*Base curves:* 4.50, 6.50 and 8.00 in clear and Kromatone 1 and 2. 7.25 base in clear only.

*Continental* INDIANAPOLIS

*FROM V. MUELLER*

# The Improved Mueller Giant Eye Magnet

**. . . with spark-free, noiseless selenium rectifier and explosion-proof footswitch control**

- Most powerful magnet of its type; yet flexible, easy to control
- Precision instrument capable of most delicate maneuvering
- Easy to operate, free from costly maintenance
- Adjustable height, direction, tilt; won't slip from set position
- Explosion-proof footswitch is master control
- Sterilizable blunt and probe tips are silvered, interchangeable

**See the Mueller Giant Eye Magnet on display at our booths (Nos. 1-5) at the AAOO Meeting in October.**

# V MUELLER & CO.

*Fine Surgical Instruments and Hospital Equipment*

330 South Honore Street — Chicago 12, Illinois

DALLAS • HOUSTON • LOS ANGELES • ROCHESTER, MINN.

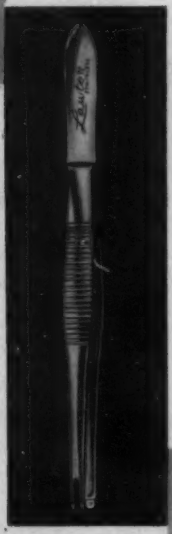
Armamentarium

---

**NEW**

# CORNEOSCLERAL SUTURING FORCEPS

*by Wes. C. Thomas, M.D.*
*Brunswick, Ga.*



An improved forceps designed to facilitate the placement of postincision sutures, and for closing traumatic openings in the cornea or sclera.

Detailed description of use may be found in the A. M. A. Archives of Ophthalmology, December 1958, Vol. 60, pp 1109-1110. Sold only through authorized surgical supply distributors.

Catalog No. 60L-2040 List Price **$12.00**

THE Lawton COMPANY

435 FOURTH AVENUE, NEW YORK 16, N. Y.

# An aid to diagnosis

A patient with polyopia, the phenomenon of multiple vision, often presents a very difficult diagnostic problem. It is necessary to know the refractive media involved in the creation of the polyopia.

Application of a contact lens becomes a valuable aid to the diagnosis as it eliminates the most important refractive surface as the possible cause of the problem. The contact lens will form a new, regular surface on the anterior portion of the eye, thereby eliminating optical distortions of the front surface of the cornea. If the polyopia disappears upon application of the contact lens, then the cornea was at fault. If the polyopia remains with application of the contact lens, the cause of the condition must then be located in some other media.

*To the center of your contact lens problem*

THE CONTACT LENS CIRCLE W J

**the Plastic Contact Lens Company**

*"Dedicated to Knowledge and Research"*

59 EAST MADISON STREET CHICAGO 3, ILLINOIS

## A Complete Glass and Plastic Artificial Eye Service

*. . . with a guarantee of satisfaction*

**FRIED & KOHLER, INC.**
665 Fifth Ave.
*Tel.: ELdorado 5-1970*
NEW YORK 22, N. Y.

**G. DANZ & SONS**
240 Stockton Street
SAN FRANCISCO 8, CALIFORNIA

**EARLE SCHREIBER**
671 Broad St.
*Tel.: MArket 2-8376*
NEWARK 2, N. J.

**ERICKSON LABORATORIES**
302 Medical & Dental Bldg.
*Phone: 2-9175*
SEATTLE 1, WASHINGTON

**GREINER & MUELLER**
55 E. Washington St.
*Tel.: FRanklin 2-4449*
CHICAGO 2, ILLINOIS

Our knowledge of shapes and colors enable us to create a superior product in every respect. We make custom-made eyes and provide perfect color matching. We match damaged or broken eyes accurately. We carry a large stock of eyes to provide quick service.

Write the manufacturer nearest you for your next ocular prosthesis.

---

## MATALENE

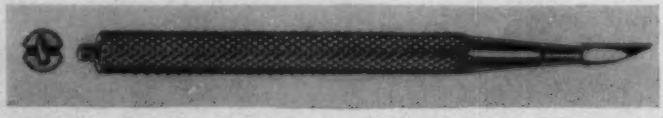
**SURGICAL INSTRUMENTS CO., INC.**

**GRAND CENTRAL PALACE BUILDING • 125 EAST 46TH ST., N. Y. 17, N. Y.**

***Successor to E. B. Meyrowitz Surgical Instruments Co., Inc.***

## A NEW INSTRUMENT FOR UTILITY PURPOSES

**by RAMÓN CASTROVIEJO, M.D., NEW YORK CITY**



RAZOR BLADE KNIFE, CRUSHER AND HOLDER

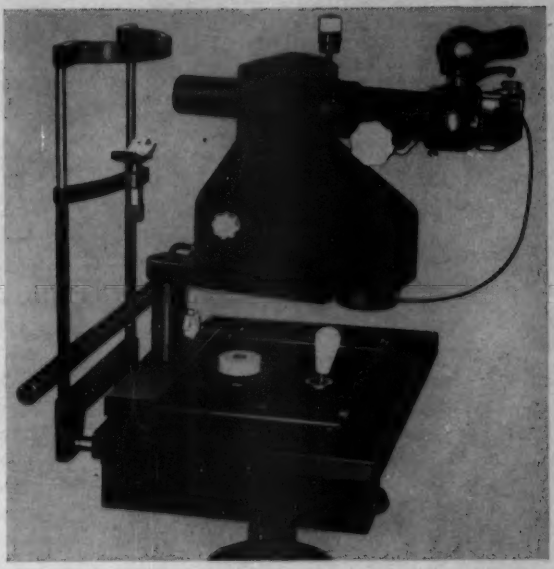
Any double edged razor blade may be used and four sharp pointed blades snapped out from one razor blade. Conveniently held for surgery. Useful for making initial incision in cataract surgery; for lid work and many other procedures.

**Stainless steel—Price $25.00**

See us at the A. A. O. O. Meeting. Booths 81-82 Palmer House, Chicago, Ill. Oct. 11th through 16th.

CARL ZEISS

WEST GERMANY



# FUNDUS CAMERA

This camera photographs a circular fundus area with a diameter of 30°—in color or black-and-white. Movements of the eye do not affect picture definition because electronic flash permits a short exposure.

Diameter of the camera's illuminating pupil is adjusted to the diameter of the patient's pupil. Optically compensates for chromatic aberration and astigmatism of the eye.

Operation of the camera is largely automatic—shutter release switches from observation to photography. Can also be used as a measuring camera. Uses standard 35mm film.

## Other Carl Zeiss Equipment

**Photo Attachments for Slit Lamp and Operation Microscope**

**Vertex Refractionometer • Diagnostic Set • Hand Lamp**

**Twin Lamp • Binocular Head Magnifier**

**Operation Microscope • Light Coagulator**

***Write for literature***

**CARL ZEISS, INC.**

485 FIFTH AVENUE, NEW YORK 17, N. Y.

COMPLETE SERVICE FACILITIES

# YOU CAN'T SEE IT...
# BUT IT'S THERE!

That's the beauty of the new Younger-22 Seamless Lens—for the early presbyope it accomplishes all the aims of the ordinary bifocal, yet to anybody on the other side of the lens, it looks like single-vision!

Why is this important to some presbyopes? Because the wearer will not show what he may view as a telltale sign of aging: a clearly visible bifocal segment.

Some people do not greet the threshold of middle age with equanimity. The only reason they will accept visible bifocals today is that they are resigned to them as the only possible alternative to poor distance-and-near vision.

The new Younger-22 Seamless Lens is an optical-quality, dual-field lens with *no sign* of the usual dividing line between powers. Not only is the segment concealed from the beholder; the wearer is not likely to be annoyed by the soft transition zone between fields.

Your early presbyopic patients will welcome this inconspicuous dual-field lens; convince yourself by trying a pair at your first opportunity!

## The *New* YOUNGER-22 Seamless Lens

YOUR PATIENT TAKES NO RISK with Younger-22s. If the patient cannot wear them for any reason, it will be replaced with a fused bifocal of your choice at no additional cost.

*Frame shown: Liberty's famous Broker 215*

2. Front surface quality and spherical accuracy to millionths of an inch.

3. Soft transition zone between fields is not likely to annoy the wearer.

1. 22mm usable segment with power deviation less than .05 diopters (4 Newton rings)—40% more precise than suggested minimum industry standards.

4. Segment and transition size deviation less than .0125mm, with no chromatic aberration—color-free.

**YOUNGER**
Los Angeles 15, California

# Many Cases of Subnormal Vision respond to "3D3"

## OPTICAID® LOOP

**Magnifies equal to 3 times in 3 dimensions with focal distance of 12 inches**

**Substantial** improvement in cases of low visual acuity is reported by Ophthalmologists with this revolutionary "3D3" OPTICAID Spectacle loop.

**Each** "3D3" OPTICAID loop is light in weight, perfectly balanced. Its lenses give high luminosity in a wide field of view. Permits adjustment of the pupilary distance from 58mm to 70mm. Provision is made for prescription glasses when necessary. "3D3" OPTICAID opens a whole new area of service, enabling you to offer substantial aid to many cases of retarded vision. Write for full details. **Retail Price $50.**

**Edroy Products Co.**

**Dept. E, 480 Lexington Avenue**

**New York 17, N. Y.**

---

**For the OPHTHALMOLOGIST and his associates in GENERAL PRACTICE.**
**The two instruments complimenting the SCHIOTZ TONOMETER.**

**BERENS-TOLMAN OCULAR HYPERTENSION INDICATOR**

This instrument is a direct reading tonometer that needs no adjustments or charts.

It is set to 25 mm. Hg. and shows instantly upon being applied to the cornea if the tension is above or below that point.

All metal parts are stainless steel and are made exactly to the standards of the Schiotz Tonometer.

Complete descriptive booklet is furnished with each instrument.

Price $18.50

**TOLMAN TONOMETER MICROMETER**

An ideal instrument for checking the readings of the Ocular Hypertension Indicator and the mechanical accuracy of the Schiotz Tonometer.

The top of the instrument is an exact 16 mm. radius test block and the dial is graduated 0 to 20 same as the Schiotz Tonometer.

Made to the same exact standards as the Ocular Hypertension Indicator.

Price $25.00

Available at all Optical and Surgical Suppliers

Manufactured By

**225 Cadwalader Ave. R. O. GULDEN Philadelphia 17, Penna.**

Schiotz Tonometer Standardization—Repair—Maintenance Service

Rx

QUALITY SERVICE

Technical skills and services that will never let you down

DOW

## Top-Grade Technical Performance

. . . a Safeguard for Your Professional Skills and Judgment.

¶Your prescriptions, conceived from your rich fund of scientific knowledge laboriously developed through years of study, training and experience, are at the mercy of the dispensers who interpret them. They will be safe in the hands of Dow seasoned craftsmen, whose devotion to the exacting standards which your professional reputation demands, and which our firm has consistently maintained throughout its 40 years of existence, is a guarantee of complete patient satisfaction.

**DOW OPTICAL CO.**

W. E. DOW, Pres.

Chicago, Ill. Bloomington, Ill.

No Prescription is Complete without

"THE BEST IN SIGHT"

**MAY·O·LITE**

*Low Reflection*

**LENS COATING**

Inexpensive vacuum coating exclusively for ophthalmic lenses that adds to comfort and efficiency. Recommended for white and tinted glasses. Extremely adherent.

- Reduces Reflection
- No "Ghost Image"
- Aids Definition, Light Transmission, Night Vision

For details, contact your Regular Optical Supplier or—

**MAY RESEARCH INC.**

Box 1167, Minneapolis 40, Minnesota

## MAGNOCULAR

*. . . A Perfect Magnifying Spectacle*

French telescopic loupe for precise operation and examination while both hands are free . . . minimum of aberration . . . large objective lenses afford large, flat field of view . . . magazine page can be viewed in magnified form at one glance.

*The surgeon's loupe, which achieved so much success at the last Academy Meeting, affords 3x magnification at a focal distance of 16 inches for eyes needing no correction.*

Standard models afford 2x and 3x magnification at 8 inches for eyes needing no correction.

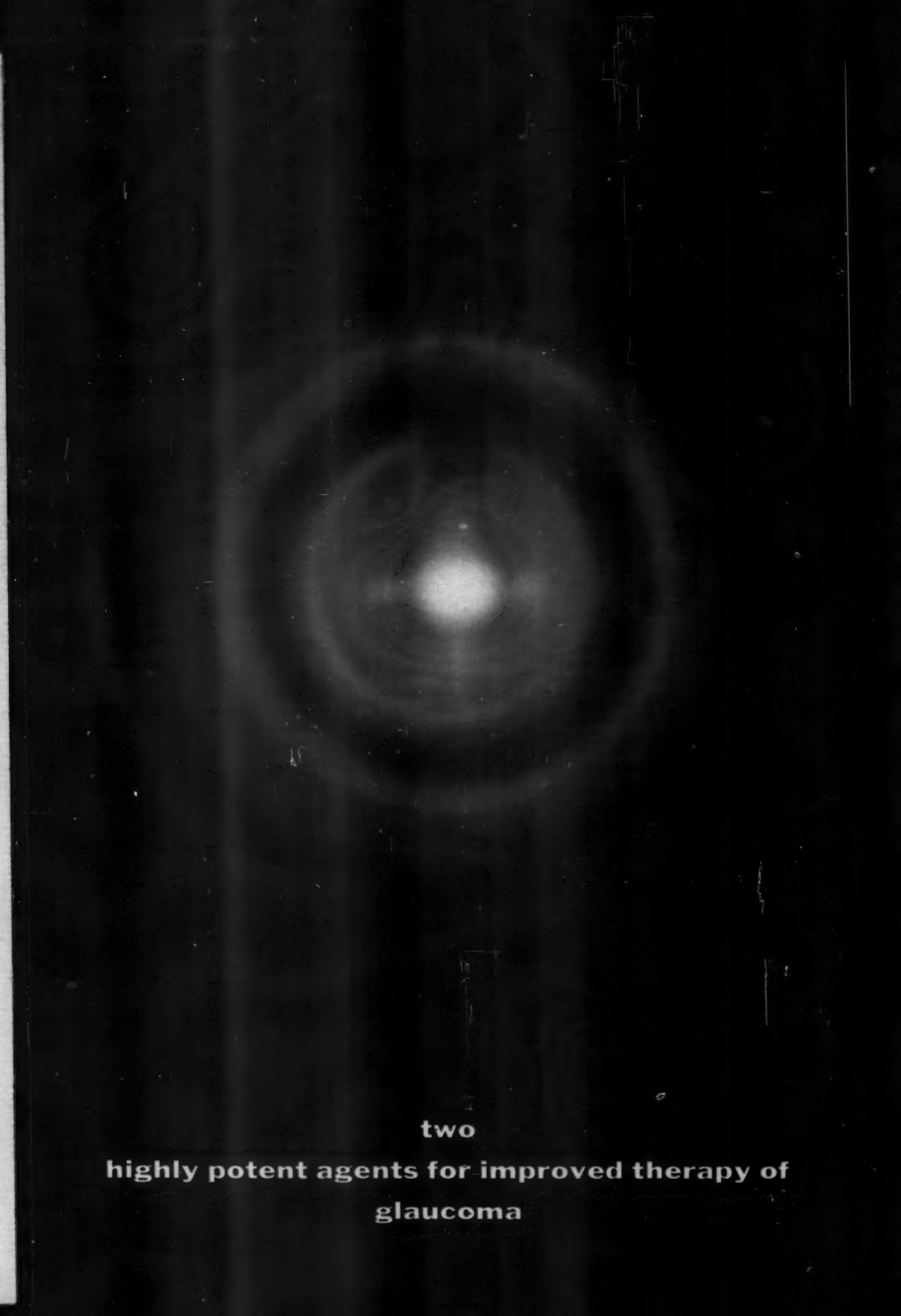
*Wearer's own correction can be incorporated easily in all models. No special trial sets necessary.*

Folds and can be carried in ordinary spectacle case.

SURGEON'S LOUPE ..... $52.50
STANDARD MODEL (3x) ..... 36.50
STANDARD MODEL (2x) ..... 32.50

**Brochure available on request**

**ARMCO MERCANTILE COMPANY**
**201 N. WELLS STREET • CHICAGO 6, ILL.**



two

highly potent agents for improved therapy of glaucoma

*oral control of intraocular pressure—even on long-term use*

# DARANIDE®

DICHLORPHENAMIDE

- inhibits aqueous humor formation
- continued effectiveness, even on long-term use
- reduces danger of metabolic acidosis inherent in other carbonic anhydrase inhibitors
- may be effective when other therapy, including miotics, has failed or has not been tolerated
- smooth control—few side effects
- low dose effectiveness—less dosage than with other carbonic anhydrase inhibitors
- fast acting
- 50 mg. tablets

*topical control of intraocular pressure*

# NEW HUMORSOL*

DEMECARIUM BROMIDE

- potent and long acting miotic
- because it is unusually potent, it may be useful in breaking up peripheral synechiae
- aqueous—isotonic with conjunctival fluid
- stable
- can be used in combination with DARANIDE
- 0.25% solution, in 5 cc. vial with dropper

*also available:* **FLOROPRYL®** *for local treatment of glaucoma and strabismus*

ISOFLUROPHATE U. S. P.

*0.1% solution, 0.025% ointment*

Detailed information on 'Daranide', 'Humorsol', and 'Floropryl' available to physicians on request.

MSD MERCK SHARP & DOHME, DIVISION OF MERCK & CO., INC., PHILADELPHIA 1, PA.

*HUMORSOL, DARANIDE, AND FLOROPRYL ARE TRADEMARKS OF MERCK & CO., INC.

# dynamic control of GLAUCOMA

**IN DIAGNOSIS** – By reducing corneal edema, DIAMOX facilitates examination and diagnosis in ophthalmologic disorders.

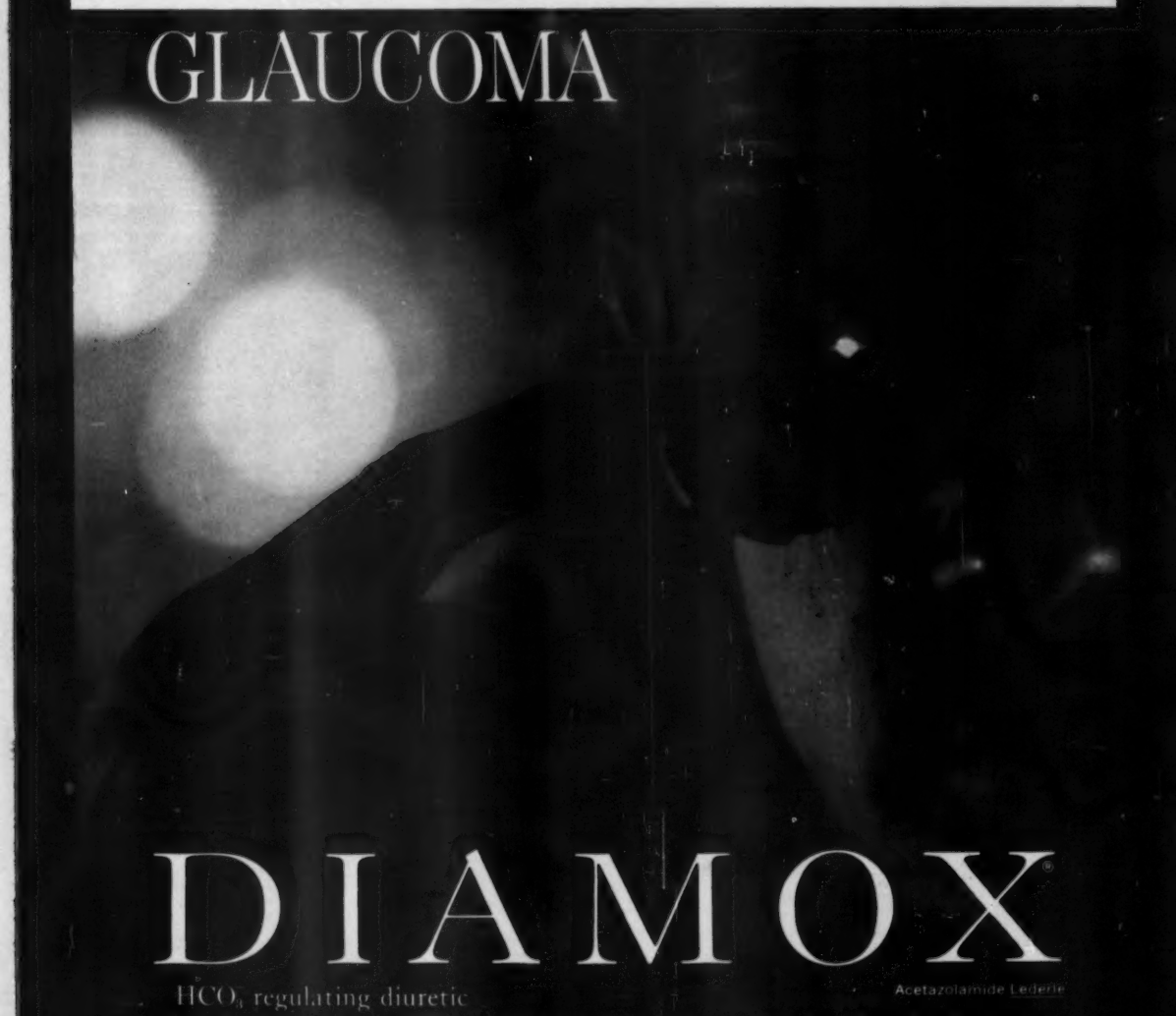
**AS THERAPY** – By lowering intraocular pressure, conservative therapy with DIAMOX can often reduce the need of surgical intervention in various glaucomatous conditions. Traumatic hyphemas, for example, can be resolved without cyclodiathermy puncture.[1]

**PRE- AND POSTOPERATIVE CARE** – Where surgery is required, tension is first reduced by DIAMOX and maintained after surgery to speed healing. Used with miotics, the synergistic action improves efficacy.[1]

Suggested DIAMOX dosage for glaucoma: 250 mg. every four hours. In severe glaucomatous crises, the intravenous form may provide quicker reduction of global pressure.

Supplied: Scored tablets of 250 mg., and Vials of 500 mg. for parenteral use.

1. Venable, H. P.: J. Nat. M. A., 50:79, 1958.



# DIAMOX®

$HCO_3$ regulating diuretic

Acetazolamide Lederle

LEDERLE LABORATORIES, a Division of AMERICAN CYANAMID COMPANY, Pearl River, New York

# a new Solution for an old ocular problem

# Prednefrin·S

OPHTHALMIC SOLUTION

Prednefrin S means new relief in sight—for patients with inflammatory and allergic disorders of the anterior segment. Prednefrin S provides potent anti-inflammatory action (0.2% prednisolone) plus the advantages of immediate and prolonged decongestant effect...in a lubricating, non-irritating, special solution—a solution which assures uniform concentrations, freedom from stinging or burning on instillation and virtual freedom from irritation for as long as therapy continues. *Taken together,* the ingredients in Prednefrin S *work together* to safeguard sight—at the site.

The complete Prednefrin S formula: prednisolone alcohol 0.2%, and phenylephrine HCl 0.12% in a sterile, lubricating solution—for prompt control of inflammatory and allergic conditions of the eyelids, conjunctiva, cornea, sclera, uveal tract and following thermal or chemical burns.

DOSAGE: 1 to 2 drops two to four times daily. In initial 24-48 hours, the dosage may be increased safely to 2 drops every hour.

SUPPLY: In 5 cc. plastic dropper bottles—on prescription only.

*Also Available*... Prednefrin® Ophthalmic Suspension—whenever the repository effect of a "solution-like" suspension and less potent anti-inflammatory action are indicated in the inflammatory conditions.

(prednisolone acetate 0.12%, phenylephrine HCl 0.12%, methylcellulose 0.12%)

ALLERGAN CORPORATION

*Los Angeles 17, California*